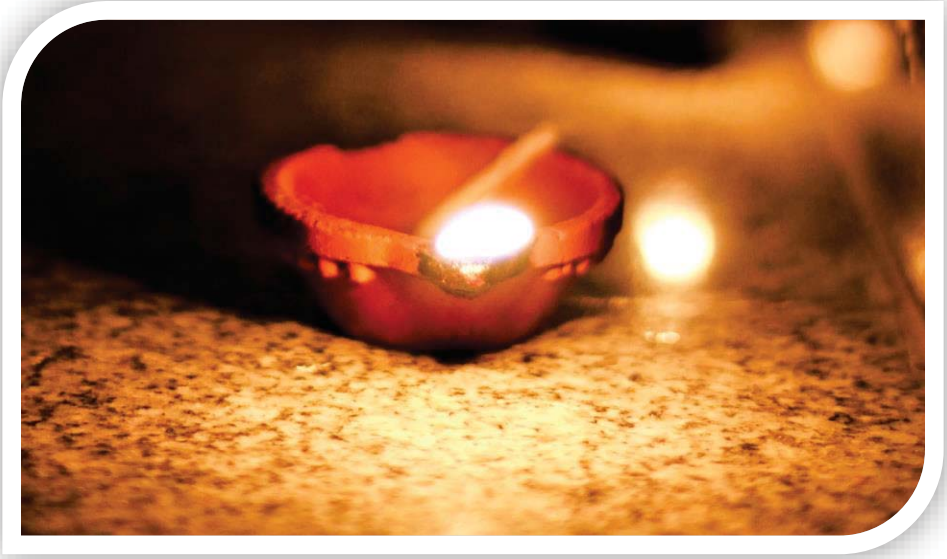
POWER SYSTEM OPERATION CORPORATION LIMITED
(A Govt. of India Enterprise)

Report on

Pan India Lights Off Event

(9 PM 9 Minutes) on 5th April 2020



Impact on Indian Power System

May 2020

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LIST OF LOAD DESPATCH CENTERS

S.No.	State/UT/Region	Location	Website
1.	Andhra Pradesh	Vijayawada	http://www.aptransco.gov.in
2.	Arunachal Pradesh	Itanagar	http://power.arunachal.gov.in/
3.	Assam	Guwahati	http://www.sldcassam.in/
4.	Bihar	Patna	http://sldc.bsptcl.co.in/
5.	Chandigarh	Chandigarh	http://chdengineering.gov.in/pages/index.htm
6.	Chhattisgarh	Raipur	http://www.sldccg.com/
7.	Delhi	Delhi	http://www.delhisldc.org
8.	Daman & Diu	Daman	https://www.dded.gov.in/
9.	Dadra & Nagar Haveli	Silvassa	https://www.dnhpdcl.in/
10.	Goa	Goa	https://www.goaelectricity.gov.in/
11.	Gujarat	Vadodara	https://sldcguj.com/
12.	Haryana	Panipat	https://haryanasldc.org.in/
13.	Himachal Pradesh	Shimla	https://hpsldc.com/
14.	Jammu and Kashmir	Jammu	http://www.jkpdd.gov.in/profile.aspx
15.	Jharkhand	Ranchi	http://www.jusnl.in/
16.	Karnataka	Bengaluru	http://www.kptcl.com/
17.	Kerala	Kalamassery	https://sldckerala.com/
18.	Manipur	Manipur	http://sldcmanipur.com/Home.aspx
19.	Madhya Pradesh	Jabalpur	http://www.sldcmpindia.com
20.	Maharashtra	Navi Mumbai	www.mahasldc.in
21.	Meghalaya	Shillong	https://meeclsldc.nic.in/
22.	Mizoram	Aizawl	https://sldc.mizoram.gov.in/
23.	Nagaland	Kohima	https://www.dopn.gov.in/irj/go/km/docs/internet/NAGALAND/Pages/Home.html
24.	Odisha	Bhubaneshwar	www.sldcorissa.org.in
25.	Puducherry	Puducherry	http://electricity.puducherry.gov.in/
26.	Punjab	Patiala	http://www.punjabsldc.org/
27.	Rajasthan	Jaipur	http://www.rajsldc.com
28.	Sikkim	Gangtok	https://power.sikkim.gov.in/

S.No.	State/UT/Region	Location	Website
29.	Tamil Nadu	Chennai	http://tnebldc.org
30.	Telangana	Hyderabad	https://www.tstransco.in/
31.	Tripura	Agartala	http://www.tsecl.nic.in
32.	Uttar Pradesh	Lucknow	http://www.upsldc.org
33.	Uttarakhand	Dehradun	http://www.ptcul.org
34.	West Bengal	Howrah	http://www.wbsldc.in
35.	North Eastern Region	Shillong	https://www.nerldc.in/
36.	Eastern Region	Kolkata	https://erldc.in/
37.	Southern Region	Bengaluru	https://www.srldc.in/SRDefault.aspx
38.	Western Region	Mumbai	https://www.wrldc.in/
39.	Northern Region	New Delhi	https://nrldc.in/
40.	Pan India	New Delhi	https://posoco.in/

ACRONYMS

AGC	Automatic Generation Control
BARC	Broadcast Audience Research Council
CERC	Central Electricity Regulatory Commission
CTU	Central Transmission Utility
DISCOM	Distribution Company
DSO	Distribution System Operator
EMS	Energy Management System
FGMO	Free Governor Mode of Operation
FOLD	Forum of Load Despatchers
FRAS	Fast Response Ancillary Services
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IEGC	Indian Electricity Grid Code
ISGS	Inter State Generating Stations
IST	Indian Standard Time
KV	Kilo Volts (Volt – unit of voltage)
MoP	Ministry of Power
MSC	Mechanically Switched Capacitor
MSR	Mechanically Switched Reactor
MVA	Mega Volt Ampere (VA - unit of apparent power)
MVAR	Mega Volt Ampere Reactive (VAR - unit of reactive power)
MW/GW	Mega Watts/Giga Watts (Watt – unit of active power)
NCOVID-19	Novel Corona Virus-2
NLDC	National Load Despatch Center
OSM	Oscillation System Monitoring
PMU	Phasor Management Unit
POSOCO	Power System Operation Corporation Limited
PSP	Pumped Storage Plant
PU	Per-Unit
RGMO	Restricted Governor Mode of Operation
RLDC	Regional Load Despatch Center
RRAS	Reserve Regulation Ancillary Services
SCADA	Supervisory Control and Data Acquisition
SLDC	State Load Despatch Center
STATCOM	Static Synchronous Compensator
STU	State Transmission Utility
SVC	Static VAR Compensator

IMPORTANT TIMELINES

S.No.	Date/Time	Important Actions	Entities involved
1	3rd Apr 2020, 0910 hrs	Appeal made by Hon'ble Prime Minister to switch off lights and light lamps and candles	All Indian Citizens
2	3rd Apr 2020 (post appeal)	Interactions to devise a plan and assess the impact on power system	RLDCs/NLDC
3	3rd Apr 2020 (post appeal)	Interactions to achieve coordination and mobilizing of resources	RLDCs/SLDCs/ Generating Stations
4	3rd Apr 2020 (post appeal)	Decision to hold FOLD meeting on 4th Apr 2020, 1100 hrs	RLDCs/SLDCs/ Generating Stations
5	4th Apr 2020, 1100 hrs	Emergency FOLD meeting convened to discuss the final operational guidelines, SLDC to give directives to DISCOMS and intra-state generating stations	SLDCs/RLDCs/NLDC
6	4th Apr 2020, Evening	Detailed advisory issued by NLDC	SLDCs/RLDCs/NLDC
7	4th Apr 2020, Late Evening	Meeting with all inter-state Hydro generating stations to discuss the strategy	SLDCs/RLDCs/NLDC/ISGS Hydro Plants
8	Midnight hours, 4th Apr night to early morning 5th Apr 2020	Mock exercise by hydro plants to assess the ramping capability	RLDCs/NLDC/Hydro Stations
9	5th Apr 2020, Morning	Directions to Transmission Licensees for reactive power support preparations and cross border support request	RLDCs/NLDC/ Transmission Licensee

S.No.	Date/Time	Important Actions	Entities involved
10	5th Apr 2020, Afternoon	Meeting of NLDC and RLDCs for review of preparatory measures, finalization of ISGS schedule	RLDCs/NLDC
11	5th Apr 2020, 1735 hrs	Security Constrained Economic Dispatch (SCED) stopped w.e.f. 1800 hrs till rest of the day to keep sufficient margins in inter-regional corridors and generating stations	NLDC/RLDCs/ISGS Thermal Plants
12	5th Apr 2020, 1830 hrs	Gas based units under reserve shutdown to be brought back on bar	RLDCs/NLDC/ Gas based Generation
13	5th Apr 2020, 1920 hrs	Backing down of Thermal generation which was earlier ramped up to meet evening peak started	
14	5th Apr 2020, 1920 hrs	Hydro generation was ramped up in proportion to the reduction in thermal generation	
15	5th Apr 2020, 1930 -2000 hrs	Opening of identified transmission lines and taking bus reactors into service for voltage control	RLDCs/NLDC
16	5th Apr 2020, 2000 hrs	Reserve Regulation Ancillary Services (RRAS) Down instructions applied for 2030-2100 hrs to keep frequency on the lower side of IEGC band	
17	5th Apr 2020, 2045 hrs	Thermal generation backed down to near technical minimum level and Hydro generation ramped up to maximum	

S.No.	Date/Time	Important Actions	Entities involved
18	5th Apr 2020, 2030 hrs	Units at Pump storage plants taken in pumping mode (Nagarjuna Sagar & Kadamparai)	
19	5th Apr 2020, 2030 hrs	Reserve Regulation Ancillary Services (RRAS) UP instruction applied for 2100-2215 hrs in anticipation of sharp rise in demand after the event	
20	5th Apr 2020, 2045 hrs	Sharp reduction in all-India demand started from 116887 MW	
21	5th Apr 2020, 2110 hrs	Minimum all-India demand of 85799 MW recorded	
22	5th Apr 2020, 2110 hrs	All-India demand started picking up	
23	5th Apr 2020, 2210 hrs	All-India demand settled at 114000 MW	
24	5th Apr 2020, 2330 hrs	Issuance of preliminary report of the lights off event by POSOCO	

*Apart from the above, Ministry of Power, Government of India had several interactions with POSOCO, Central Sector Generating companies and POWERGRID on 3rd, 4th and 5th April 2020 in connection to the #9pm9min lights off event.

DATA SOURCES

The source of data utilized for analysis and preparing various trends, plots and data tables presented in different chapters of the report and annexures is given below.

Chapter	Name	Data Source
1	Background	NA
2	Preparedness for the Lights Off Event	NLDC SCADA
3	Operations during the Lights Off event	NLDC SCADA
4	Reports by State Load Despatch Centers on the Lights Off Event	Reports submitted by SLDCs RLDC SCADA (for plots)
5	Demand Variation	NLDC SCADA
6	Inter-Regional and State Drawls	NLDC SCADA
7	Generation Management	RLDCs SCADA
8	Response of Pumped Hydro and Lift Irrigation Projects	RLDCs SCADA
9	Cross- Border Support from Bhutan	ERLDC SCADA
10	Frequency Trend	NLDC PMU
11	Voltage Management	RLDCs SCADA NLDC PMU (for voltage unbalance)
12	Angular Separation	NLDC PMU
13	Power System Modes	NLDC PMU
14	Analysis of Demand Reduction	NLDC SCADA BARC India (TV Viewership Data)
15	Key Learnings	NA

Sampling Rate

SCADA Data – 1 min. (to address the latency in data due to non-simultaneity and data availability of measurements from multiple locations routed through multiple control centers)

PMU Data for Frequency – 40 millisecond

PMU Data for Voltage Unbalance – 1 sec.

The source of data or information taken from any other platform has been mentioned along with that data in the report.

DEMAND CALCULATION METHODOLOGY

The methodology for calculation of demand of each state, region and all India at NLDC/RLDCs is as under:-

1. State Demand at RLDCs is worked out as the sum of all the intra-state generation (ex-bus) and the net drawl of the state. This involves the algebraic summation of outputs of several MegaWatt transducers installed on all outgoing lines from the intra-state power plants and all the tie lines connecting to the respective state.

   State Demand = ∑Intra-State Generation + ∑Tie line flows connecting to the respective state

   Thus, the state demand worked out above includes the intra-state transmission losses.

2. Regional demand can be worked out in two ways.

   2.1 Sum of all state demands within the region worked out at point-1 above.

   Regional Demand = ∑Demand of states within the region

   This is the methodology followed at Northern, Western and North- Eastern Regional Load Despatch Centers. The regional worked out in this manner therefore excludes the inter-state transmission system (ISTS) losses within the region.

   2.2 Sum of all intra-regional generation (ex-bus) and the net drawl of the region.

   This involves the algebraic summation of outputs of several MegaWatt transducers installed on all outgoing lines from the intra-regional power plants (state as well as regional entity power plants) and all the tie lines connecting to the respective region.

   Regional Demand = ∑Intra-State Generation + ∑Regional Entity Generation + ∑Tie line flows connecting to the respective region including cross border ties

This is the methodology followed at Southern and Eastern Regional Load Despatch Centers. The demand worked out in this manner includes the inter-state transmission system (ISTS) losses within the region.

3. All India Demand is worked out as the sum of regional demands.

All India Demand = ∑Demand of all the regions

The primary data flow of various parameters is indicated below: -

S. No.	Parameters	Data Flow
1.	Intra-State Generation	RTU to Sub-LDC (if any) to SLDC to RLDC to NLDC
2.	Inter-State Generation	RTU to RLDC to NLDC
3.	Tie line flows at state end	RTU to Sub-LDC (if any) to SLDC to RLDC to NLDC
4.	Tie line flows at ISTS end	RTU to RLDC to NLDC

At National Load Despatch Center (NLDC), only the all India demand is computed while the state and regional demands are considered as worked out by respective RLDCs at point-1 & 2 above. Hence, at NLDC, the sum of state demands would not exactly add up to the all India demand in view of the variation in methodology as indicated at point-2 above. This difference would be of the order of 1200-1800 MW (1-1.5% on all India level) depending on the system size. This difference is for the absolute value of the estimated demand.

In this report, the focus is on relative change or reduction in demand, where the different methodologies described above have a negligible impact. Considering the non-simultaneity and data availability of measurements from multiple locations, both on the generator side as well as the tie lines, exact matching of demand reduction with generation reduction is practically difficult. This aspect may be kept in mind for better appreciation of the figures mentioned in the report.

MESSAGE FROM SECRETARY, MINISTRY OF POWER

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May 6, 2020

MESSAGE

India's fight against Covid-19 pandemic is people-driven and along with the people, the Central & State Governments and the entire Indian power sector are jointly fighting the pandemic. The Hon'ble Prime Minister of India made an appeal to the citizens at 9 AM on 3rd April 2020 to switch off their electric lights and light candles for 9 minutes at 9 PM on 5th April 2020. It was a symbolic gesture to show the resolve and commitment of the nation towards fighting the pandemic with light and hope.

Managing the 31 GW sharp variation in demand calls for adequate reserves & flexibility of resources and this was demonstrated during the successful management of the event. Hon'ble Minister of State for Power (I/c), other senior officers of the Ministry and I witnessed the event from the National Power Monitoring Center (NPMC). The flawless execution of the entire operations indicated high level of meticulous planning, preparations & coordination among the stakeholders countrywide. The strategic operation of hydro as high ramping resource during the event was quite helpful and hence, future role of hydro/pumped-hydro in the generation mix assumes significant importance.

The entire power sector fraternity across the complete value chain from generation to transmission to distribution rose to the occasion in managing this event smoothly which was coordinated in an exemplary manner by all the Load Despatch Centres (LDCs) involved. This report has covered various important aspects such as advance actions taken for the event, mock trials, generation resource management, voltage & frequency management, consumer behaviour etc.

I would like to congratulate all the stakeholders for successfully managing the event. The learnings from this event would go a long way in handling the electricity grid of the future.

(Sanjiv Nandan Sahai)

RIGHT TO INFORMATION

ACKNOWLEDGEMENT

The #9pm9min lights off presented a unique challenge to the Indian Power System demanding profound technical expertise, meticulous planning, precise coordination, and above all perfect execution by multiple power sector entities within a short time of frame. It gives me immense pleasure and satisfaction that each power sector stakeholder confidently took up this challenge as an opportunity and demonstrated the strength of the Indian Power System.

I, on behalf of the POSOCO team, would like to thank all the State Load Despatch Centers (SLDCs) for attending emergency FOLD (Forum of Load Despatchers) meetings on short notice, providing valuable feedback, smooth coordination with RLDCs and all the entities in their respective control areas.

The team is also thankful to all the generating stations across the country for providing vital support by modulating the generation as per requirement during the event. The flexibility provided by the hydro stations was exemplary to meet this challenge.

The team would also like to acknowledge the support provided by the Central Transmission Utility (CTU) viz. POWERGRID, all the State Transmission Utilities (STUs), other transmission licensees and DISCOMs across the country by timely implementing the necessary control measures advised by the load despatch centers before and during the event.

The team is also grateful to the entire Ministry of Power, Government of India for their invaluable guidance and support during the entire planning and management of the event.

(K.V.S. Baba)
Chairman and Managing Director
Power System Operation Corporation Ltd.

EXECUTIVE SUMMARY

"दीपज्योतिः परब्रह्म दीपज्योति जनार्दनः ।
दीपो हरतु मे पापं संध्यादीप नमोस्तुते ॥"

The Hon'ble Prime Minister of India made an appeal to the citizens of the nation at 09:10 hrs of 3rd April 2020 to switch off their switch off lights for 9 minutes and light candles, diyas, torch, or mobile flash lights starting at 2100 hrs of 5th Apr 2020. The message behind this symbolic gesture was to *"let the brightness of the lights ignite our energies and ensure the victory of good over evil."*

The event, famously known as #9pm9min event, was unique in itself as it involved reduction of pan-India lighting load within a short duration of time with subsequent sharp recovery of the same after 9 minutes. The response shown by the public, four weeks earlier, to a similar appeal of showing the support to the corona-warriors across the country by clapping and cheering from their balconies indicated that the #9pm9min lights off event was also likely to receive a massive response from the citizens. The successful management of the event, therefore, required meticulous planning and close coordination between all the power sector entities.

Considering the crucial role of system operators in successfully managing the #9pm9min event, POSOCO (National and Regional Load Despatch Centers) in coordination with State Load Despatch Centers (SLDCs) started preparing for the event immediately after the appeal of Hon'ble Prime Minister. During the course of this preparation, several web-based meetings and interactions were held with State Load Despatch Centers (SLDCs), Generating Stations and Transmission Licensees on high priority. The brainstorming during these meetings helped in arriving at a modus-operandi which culminated into a detailed advisory for managing the event. The advisory assumes uniqueness as it provided a holistic view of the power system operation during the forthcoming event. Every stakeholder was assigned specific responsibilities and compliance of same was ensured to the extent possible. The advisories and timely press releases by the Ministry of Power, Government of India helped in providing the desired directions to general public and dispelling the apprehensions and rumors surrounding the event.

The most challenging aspect in managing the event was to match the sharp rate of change of demand with matching change in generation across the country. The anticipated sudden changes in load were planned to be managed via high ramping resources (Hydro and Gas

generation) with cyclic capability. The schedule of these high ramping resources was carefully coordinated in order to achieve maximum flexibility during the event. Necessary provisions in other generation sources such as slow ramping coal-fired stations along with the wind farms were also ensured to get the desired generation relief. Further, the desirable voltage profile along with the reliability of the transmission network were ensured by taking adequate preparatory measures based on the load flow simulations and other established inputs.

In line with the expectations, the #9pm9min event received overwhelming response from all corners of the country and significant demand reduction was observed in almost every state. This fall in demand of **31089 MW** during the event was managed effectively with matching generation back down in various types of generators across the country. Generation reduction of **17543 MW** during the event was achieved through hydro resources with substantial additional relief of **10950 MW** coming through other sources viz., Thermal (7240 MW), Gas (1950 MW) and Wind generation (1998 MW). This recovery of load was again managed with corresponding increase in hydro, thermal, gas and wind generators.

The maximum rate of fall and rise in demand recorded during the event was **4196 MW/Min** and **3015 MW/Min** respectively. The maximum rate of change in generation was -**4312 MW/Min** and **+2839 MW/Min** with maximum ramp rate of **-2728 MW/Min** and **+1977 MW/min** provided by hydro generators. During the entire period of the event, Indian power system was operated as a single control area (solely for the purpose of frequency control) with all the major stakeholders in online video or tele-conferencing mode with real time grid operators at NLDC and RLDCs. The coordinated and timely actions of all the stakeholders ensured that the event managed successfully without any untoward incident and power system parameters were maintained within limits. The details of planning and actual operations during the #9pm9min event are provided in Chapter-2 “Preparedness for the Lights Off event” and Chapter-3 “Operations during the Lights Off event” of the report.

The management of the Indian power system during the #9pm9min event has been appreciated worldwide and the technical expertise and precise coordination between the different entities is being considered as a subject for case study. POSOCO has tried to record the planning, execution as well as various other facets of the event in the form of this report. The report covers detailed analysis of pan-India, regional and state-wise demand patterns, node wise response of active and reactive power variation by

generators, analysis of frequency and voltage profile, their correlation, and voltage unbalance with dedicated chapters on each topic. The response of FACTS devices along with system stability aspects such as power system modes and angular separation have also been captured in the report. A sample analysis of additional load reduction than anticipated in urban clusters has also been presented in the report. Television viewership change during the event recorded by BARC (Broadcast Audience Research Council) has also been presented to highlight that demand reduction occurred not only due to residential light switching off but other appliances also. Data from various sources viz., NLDC & RLDC SCADA and PMU (Phasor Measurement Units), SLDC data (available on public domain) etc. has been utilized to elucidate each and every topic covered in the report.

The report aims at not only facilitating further learning and knowledge dissemination in this direction, but also to act as a source of inspiration to the entire Indian power sector of India which acted in unison to successfully manage this unprecedented event.

"शुभं करोति कल्याणमारोग्यं धनसंपदा ।
शत्रुबुद्धिविनाशाय दीपज्योतिर्नमोस्तुते ॥"

DISCLAIMER

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1 Background

The Hon'ble Prime Minister of India appealed to the citizens of the country at 09:10 hrs of 3rd April 2020 to switch off their lights and light lamps or candles for 9 minutes at 21:00 hrs of 5th April 2020 to show solidarity and confidence in the nation's collective fight against the novel coronavirus. The message behind this symbolic gesture was to *"let the brightness of the lights ignite our energies and ensure the victory of good over evil."*

There was a massive response to Hon'ble Prime Minister's appeal and millions of Indians across the country switched off lights at their homes and lit candles or lamps on Sunday (5th April) night. The effects of this overwhelming response were also visible in the power sector with all India demand falling sharply from **116887 MW at 20:45 hrs to 85799 MW at 21:10 hrs.**

Figure 1: Residents lighting lamps at 21:00 hrs on 5th April 2020[1]

Despite the sharp reduction of **31089 MW** in all India demand within minutes and subsequent restoration of same after a short while, the event was managed successfully with the synchronized actions of all the Load Despatch Centers, Generating Stations, Transmission Licensee, and DISCOMs across the country.

This report tries to bring the various facets of the event, and insights into what all went into planning, managing as well as analysis of the event.

[1] *Image Source: https://www.newindianexpress.com/galleries/nation/2020/apr/06/diya-jalao-here-is-how-india-responded-to-pm-narendra-modis-9-pm-9minutes-appeal-102824--8.html*

2 Preparedness for the Lights Off Event

"By failing to prepare, you are preparing to fail." — Benjamin Franklin

Immediately after the appeal of Hon'ble Prime Minister on 3rd April, POSOCO started the planning for managing the sharp fall and rise in demand during the event. The leadership at POSOCO including heads and other experts at National and Regional Load Despatch Centers (NLDC and RLDCs) started discussions with various stakeholders. All possible media were used for these interactions including blogs, e-mails, conferences, and messaging. Discussions covered the various resources available, mobilizing them, and likely impact of the event on the load generation balance, system voltages and stability of the all India electricity grid along with the action plan to manage the same.

RLDC heads also started discussions with the respective State Load Despatch Centers (SLDCs) and generating stations in respective regions for necessary coordination. There were preliminary meetings through video conferencing calls about various ways to start the preparations and devising a common action plan to be followed across the country.

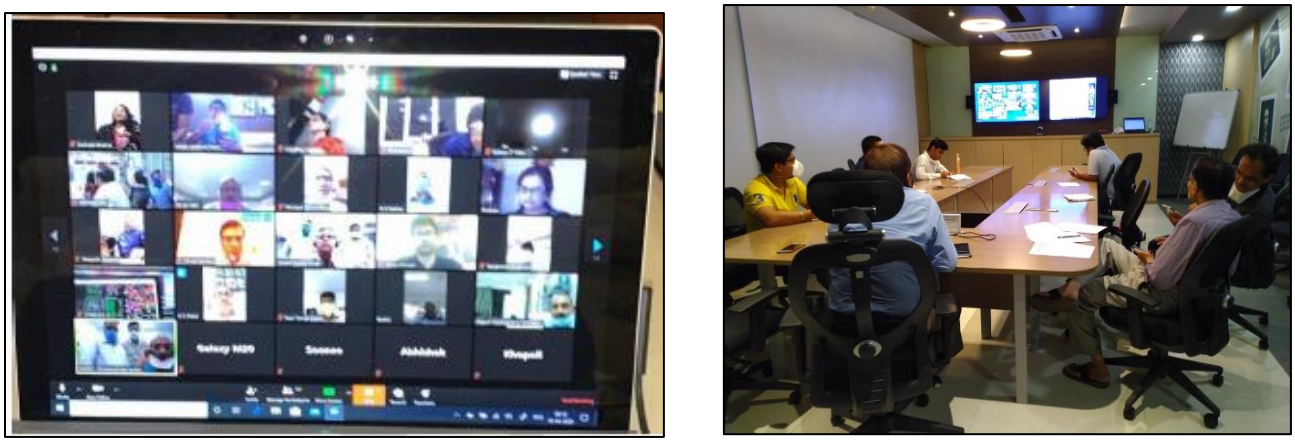


Figure 2: WRLDC and ERLDC Nodal officers meeting with respective stakeholders

It was also decided that an emergency meeting of Forum of Load Despatch Centers (FOLD) would be convened at 11:00 hrs of 04th April 2020 to discuss and finalize operational guidelines for managing the event. The rationale was to harmonize, strategize and align all the actions as per these finalized guidelines.

RLDCs were also requested to advise all the SLDCs in their respective areas to estimate the likely demand reduction along with preparing the plans to meet the challenge.

The preparation of the event was classified into following categories.

a) Estimation of demand reduction during the 9 minutes of lights off event
b) Operational Plan for successfully managing the event
c) Coordination with various stakeholders
d) Execution of the plan on 5th April 2020

2.1 Estimation of demand reduction during 9 minutes of lights off event

Prior to the lights off event, the all India demand was already reduced by 30-40 GW compared with the usual demand on daily basis in the month of April due to countrywide lockdown since 25th March 2020. The demand comparison for first week of April 2020 w.r.t. last year is given below (https://posoco.in/covid-19/).

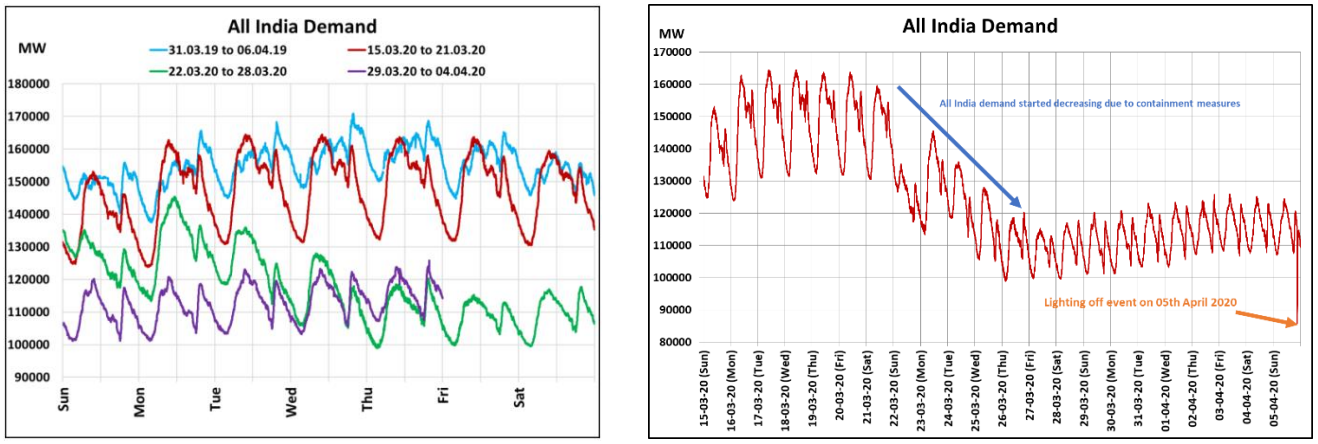


Figure 3: Demand Reduction due to countrywide lockdown

In this existing low demand scenario, the accurate estimation of the demand reduction during the event was a challenge and at the same time of utmost importance for successfully managing the event. Accordingly, the first exercise carried out in preparation for the event was the anticipation of reduction in demand due to switching off of lighting load at 21:00 hrs.

The anticipated reduction was worked out on 3rd April 2020 using following methodologies. These methodologies could be classified as one from overall impact perspective and other more granular bottoms up approach.

a) **Overall Impact or Top down Approach:** As there was no commercial and industrial load in the system due to countrywide lockdown since 25th March 2020, the change in prevailing all India demand between 18:00 hrs and 21:00 hrs was primarily attributed to the lighting load of household consumers. Based on this analysis, the all India lighting load was estimated and demand reduction of **11344 MW** at 21:00 hrs was anticipated.

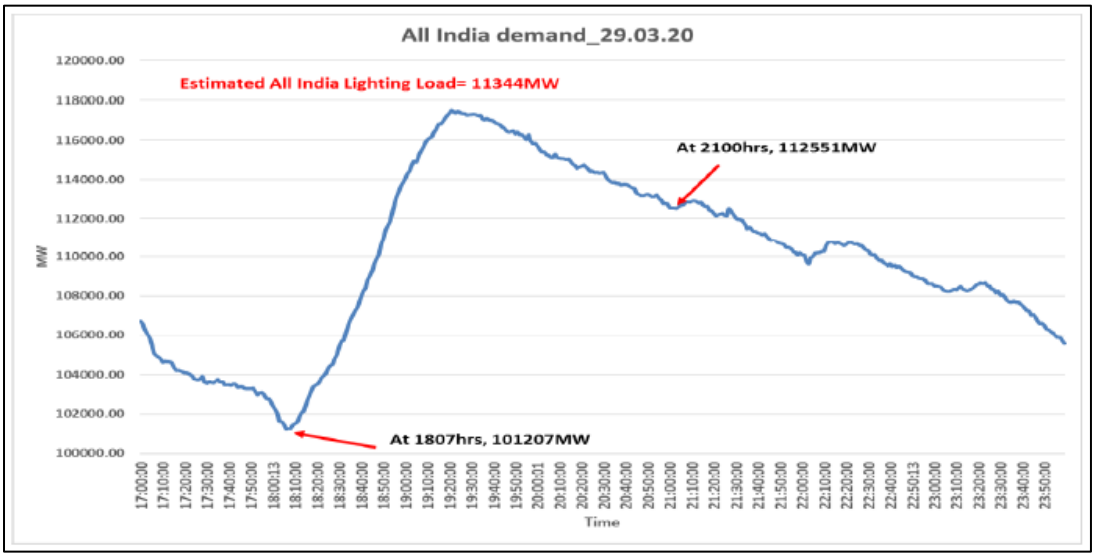


Figure 4: Estimation of all India lighting load

b) **Granular Bottoms Up Approach:** In addition to above, an entirely independent exercise based on the number of household consumers in India was carried out to find the total demand reduction at grid level. The data of number of rural and urban household consumers in India was taken from **Saubhagya web portal** and it was assumed that , on average, the load of each rural and urban household consumer will reduce by 50 and 100 Watts respectively (considering impact of LED lighting). The demand reduction figure estimated after this exercise was **12452 MW** assuming participation of 80% households in the event**.**

The anticipated demand reduction in each state was also worked out separately by respective State Load Despatch Centers (SLDCs) and the summation of demand reduction anticipated by SLDCs for respective states was approximately **15085 MW.**

Based on the demand reduction figures computed from above methodologies and as per inputs received from SLDCs, it was anticipated that the total reduction in domestic lighting load on all India level will be in the range of **12-15 GW.**

One major issue faced in accurately anticipating the demand reduction was to predict the behavioral aspect of consumers. Right after the announcement of lights off event, various suggestions started floating in social media and other platforms such as the need to switch off all household appliances for the safety of equipment. This implied that the demand reduction would be much more than the estimated reduction due to switching off the lights alone. Another suggestion being made was to switch on additional devices to reduce the effect of sharp reduction in demand because of switching off the lights. These suggestions created a huge amount of uncertainty in forecasting the kind of response and consequential reduction in demand.

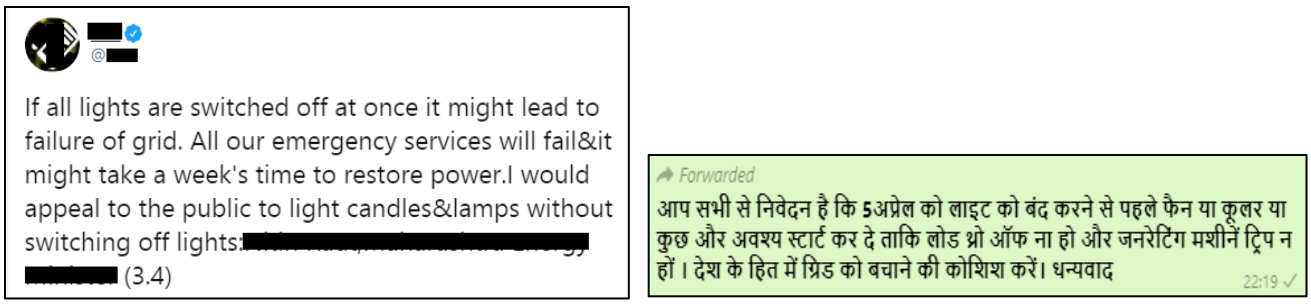


Figure 5: Suggestions floating on social media

The plethora of messages on social media made the task of demand estimation very challenging with high uncertainties on both sides.

In order to dispel all the apprehensions regarding safety of electrical appliances surrounding the event, the Ministry of Power issued a press release https://pib.gov.in/PressReleseDetail.aspx?PRID=1611020 on 4th April 2020. The press release clarified the following:-

a) Electrical appliances such as ACs, Fans, TVs, Refrigerators etc. are not supposed to be switched off and only household lights are to be switched off from 21:00 hrs to 21:09 hrs on 5th April 2020.

b) Street lights as well as lights in all essential services like hospitals, police stations, manufacturing facilities etc. will remain on.

Further, for allaying all doubts about grid instability during the lights off event, another press release https://pib.nic.in/newsite/pmreleases.aspx?mincode=52 with detailed FAQs (frequently asked questions) on power grid operations during the event was issued on 5th April 2020 by the Ministry of Power. The advisory, press release and FAQs by Ministry of Power, Government of India are enclosed at **Annexure- 2.1**.

2.2 Operational Plan for successfully managing the #9pm9min event

After the anticipation of estimated reduction in demand during the event, the focus shifted on preparing a sound strategy to manage the event. The sharp reduction in demand and subsequent recovery expected in such a short duration was unprecedented and managing the power system parameters within limits during the event was a challenging task. A detailed plan, therefore, was prepared to achieve the following three objectives and successfully handle the event.

a) Ensuring load-generation balance at all times during the event for frequency control

b) Ensuring voltages are within permissible limits at all nodes

c) Ensuring transmission network loadings within permissible limits along with system stability

2.2.1 Load- Generation Balance and Frequency Control

The management of anticipated sharp reduction in demand and subsequent recovery required high ramping resources with flexible characteristics. The high ramping resources such as hydro[2] and gas generators are available in the Indian power system and these had to be effectively harnessed for this event.

[2] *The flexibility of hydro resources is being utilized on daily basis by system operators. A detailed report on hydro flexibility was brought out by FOLD in June 2017 is available at - https://posoco.in/hydro-committee-report/*

The information about the Inter-state hydro generator's capabilities, forbidden zones, and minimum generation possible etc. was readily available with NLDC and RLDCs as same was earlier collected for operationalization of pilot project on Fast Response Ancillary[3] Services (FRAS) in accordance with the directions of Hon'ble Central Electricity Regulatory Commission (CERC). The details on this are available in feedback report of the POSOCO on FRAS and can be accessed through the link: - https://posoco.in/wp-content/uploads/2019/08/POSOCO_FRAS_Feedback.pdf.

The operation ranges of active power of a typical hydro generating unit are as given below.

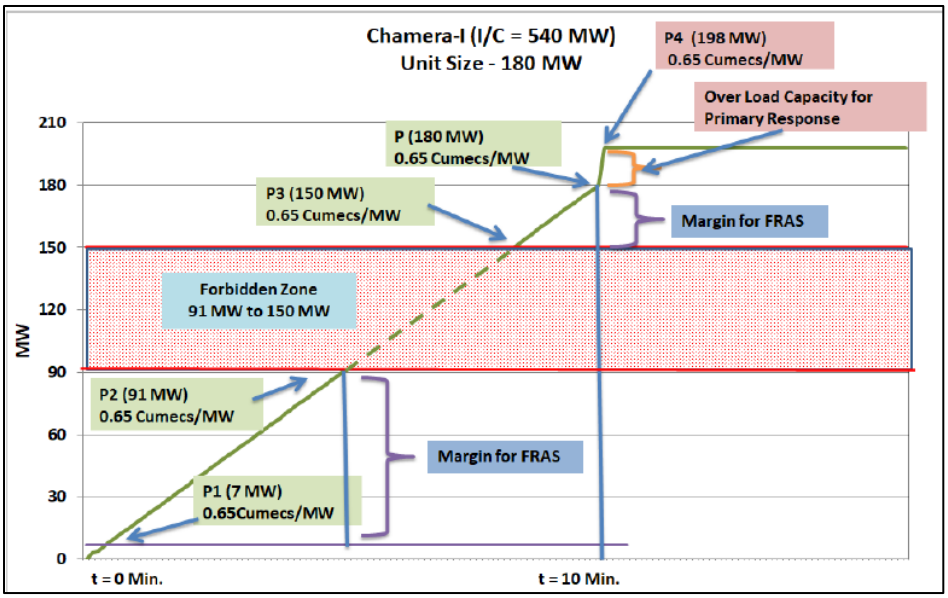


Figure 6: Operating Range of Chamera- I HEP (Unit Size – 180 MW)

- P1 - Minimum load at which unit can stably run after synchronization
- P2 to P3 - Forbidden zones or high cavitation zones
- P4 - Maximum loading possible on unit (continuous)

Accordingly, a list of all the hydro and gas generating stations across the country was prepared and an exercise was carried out to determine the flexibility available with these resources that could be utilized during the event. Further, in order to have this flexibility in the system at the right time, following major action points were decided:-

[3] *Ancillary Services mean the services necessary to support the power system (or grid) operation in maintaining power quality, reliability and security of the grid and include secondary response, tertiary response, active power support for load following, reactive power support and black start.*

a) Conservation of hydro energy during the evening peak hours through reduction in hydro generation and replacing the same from thermal fleet. This saving of water or hydro energy during evening peak was to be utilized for bringing hydro generating units on bar before (to create capability for fast ramping down) and immediately after the #9pm9min event (for fast ramping up).

b) Reduction in schedule of Inter-state thermal generating stations to near technical minimum level of 55-60% just before the start of the #9pm9min event in order to have room for maximization of hydro generation before #9pm9min.

c) Fast ramping down the hydro and gas generation with the start of #9pm9min event while keeping a watch on the system frequency.

d) Ramping up of thermal generation from 21:05 hrs onwards so that it can supplement hydro generation during demand build up phase immediately after #9pm9min. Further, ramping up of hydro generation matching with recovery of demand keeping a watch on system frequency.

e) Automatic disconnection of Inter-state wind generators from the grid at frequency beyond 50.20 Hz.

f) Reduction of governor droop[4] setting of hydro units from usual level of 4-5% to 1-2% or whatever lower value feasible.

g) All other generating units to have the frequency response in "on" condition with usual droop characteristics.

One major concern in arresting significant variations in grid frequency during the event was low inertia[5] of the system since the countrywide lockdown on 25th March 2020. Due to the reduced demand in the system because of lockdown, many generating units were desynchronized from the grid causing significant reduction is system inertia. In order to

[4] ***Governor Droop:*** *In relation to the operation of the governor of a generating unit, droop means the percentage drop in system frequency which would cause the generating unit under governor action to change its output from zero to full load.*

[5] ***Inertia*** *means the contribution to the capability of the power system to resist changes in frequency by means of an inertial response from a generating unit, network element or other equipment that is coupled with the power system and synchronized to the frequency of the power system.*

take care of this aspect, it was planned to bring additional hydro and gas units on bar (along with the coal/lignite based generation) for the event.

2.2.2 Voltage Control

All India demand was already 30-40 GW less than the usual demand in the month of April 2020 due to countrywide lockdown since 25th March 2020. Nearly 180-200 lines at 400 kV and above voltage level were already being opened/kept open for voltage control on a daily basis. These measures had successfully helped in keeping the system voltages within the mandated Indian Electricity Grid code (IEGC) band. It was anticipated that opening of these lines before #9pm9min event will keep enough margin in the system for maintaining voltages within operational limits during the event.

Apart from above following actions were also planned to be taken before the event: -

a) All bus reactors would be taken in service by 2000 hrs even if voltages are slightly lower than 1 PU at 400 kV and above voltage level nodes.

b) List of lines which could be further opened without loss of reliability was prepared. All such lines could be opened before the event.

c) All the STATCOMs and SVCs would be operated in voltage control mode with reference voltage being 1 PU.

d) All generating stations were to keep voltage regulator in automatic mode and allow the utilization of full capability curve of the unit during the event.

e) With lower active power generation at generating units, increase in the reactive power capability need to be utilized as dynamic reactive reserves in the system.

Simulation studies were carried out for the minimum anticipated demand and generation scenario for the event and also for the scenario of minimum demand met so far during the lockdown period. The simulation results gave confidence that critical issues on the voltage control front are unlikely to be faced during the event.

2.2.3 Power System Stability and Transmission Network Loading

The network loading in different corridors were already low in view of complete lock down in the country and therefore, sufficient margins were available in different corridors. Further, in addition to above, #9pm9min impact was also likely to be a distributed phenomenon across whole nation and therefore, any major concern was not anticipated. However, simulations studies were conducted and power system was observed to remain stable during the event.

Apart from above, it was also planned to utilize the Phasor Measurement Unit (PMU) data available at control centers minutely during real time for any signs of instability or oscillations, or high angular spread.

2.3 Coordination with Various Stakeholders

The next task was to discuss these operational guidelines or plans among all the stakeholders i.e. RLDCs, SLDCs, generating stations, and transmission licensees to firm up the plans, make any readjustment in the plan and align all stakeholders to take coordinated actions. Accordingly, several meetings with different stakeholders were convened on 3rd, 4th and 5th April 2020. The movement restrictions due to lockdown in the country was an issue but organizational arrangements, institutionalization of Forum of Load Despatchers (FoLD) and use of information and communication technology (ICT) enabled seamless interactions with all the stakeholders.

2.3.1 Emergency FOLD Meeting, Finalization & Issuance of Operational Guidelines

A meeting of all SLDCs, RLDCs and NLDC (Forum of Load Despatchers Meeting) was convened at 11:30 hrs on 4th April 2020 to discuss the operational plan prepared by POSOCO and receive inputs from all the stakeholders for managing the event. Each SLDC mentioned their anticipation of load reduction, presented their preparations for the event along with the coordination plan with intra-state generating stations and DISCOMs. They also confirmed about the capability of smaller hydro generating stations in their respective control areas.

SLDCs also briefed about the voltage control measures being taken in the respective state like opening high reactive power producing 220 kV cables and 132 kV lines while keeping system reliability in mind. The states having pump storage facilities and lift irrigation facilities were requested to take these facilities in pumping mode before the start of the event. These pumps were to be tripped if system frequency drops during the event or demand build up phase. It was made amply clear not to resort to either load shedding or activation of any additional supplies (not as per normal supply hours for agricultural supply). All SLDCs were also advised to ask respective DISCOMs to spread the message among general public that only residential lights to be switched off and no other house hold appliances to be switched on or off. This was done to avoid any additional uncertainty in the plans.

As per these deliberations, the sum of anticipated demand reduction of all states as estimated by respective SLDCs was 15 GW with flexibility in hydro and gas generating plants estimated to be 21 GW.

After deliberations in the meeting, detailed operational guidelines were finalized and issued by NLDC on 4th April 2020 evening (copy of operational guidelines enclosed at **Annexure-2.2**). In line with the detailed operational guidelines issued by NLDC, advisories were issued by most of the State Load Despatch Centers to respective stakeholders for reliable operation of the grid during the event.

Figure 7: Meeting of SLDCs, RLDCs and NLDC on 4th April 2020

The salient features of the guidelines issued by NLDC are as follows:-

a) Generation and Frequency Control

- All clocks at generating stations to be synchronized to Indian Standard Time (IST).
- Hydro to be conserved during evening peak; to be replaced with thermal and gas generation.
- After evening peak, thermal would be reduced with increase in hydro till 20:55 hrs
- Hydro and gas would be ramped down from 20:57 hrs keeping a watch on frequency.
- Thermal generation to be ramped up from 21:05 hrs; Hydro and Gas ramping to start from 21:09 hrs.
- Automatic disconnection of wind generators with frequency going beyond 50.2 Hz
- Primary response of all generators to be in service. Hydro plants to have droop setting of 1-2%
- All defense mechanisms to be maintained in healthy condition and in service.

b) Voltage Control

- All reactors to be taken in service by 20:00 hrs.
- STATCOMs and SVC to be operated in voltage control mode with reference of 400 kV.
- Capacitors at distribution level to be kept off.
- Thermal machines to regulate AVR to absorb maximum VAR as per the under excitation capability of the machine and grid voltage requirement.

c) In order to improve resiliency, all black start stations were advised to remain under state of readiness.

2.3.2 Meeting with Hydro Generators

A separate meeting with ISGS hydro generating plants was also convened on 4th April 2020 evening wherein the importance of timely ramping (down and up) of hydro generation matching with the demand reduction during the event was emphasized. Some of the generating stations further agreed to reduce the minimum level of operation, if required,

and thus offered more flexibility. Most of the stations agreed to reduce the droop setting to 1-2% while some of them agreed for 3% droop. Apart from above following was also agreed: -

a) A detailed procedure for ramping up/down the generation w.r.t. system frequency would be given to all the generating stations.

b) A generating company/power plant will issue a clear detailed internal action plan for the engineers on the operation desk.

c) A mock exercise for load set point change with reduced droop setting would be done in coordination with all the RLDCs at all the power plants during night of 04th April or in the morning of 05th April 2020 and performance would be recorded.

d) It was also advised that the operating engineer who is likely to be on operation desk at 21:00 hrs of 05th April 2020 shall also be present during these mock exercises so as to get familiar with all the requirements and procedures.

e) The confirmation of the above actions was to be given to the respective RLDCs.

f) All RLDC heads were requested to discuss the same with concerned SLDCs for similar mock exercises and detailed internal action plan for all intra-state hydro plants.

2.3.2.1 Results of the mock exercises and confirmation of detailed action plan

An elaborate mock exercise on hydro ramping was carried out by hydro stations successfully on 4th April 2020 night and 5th April 2020 morning to ascertain the required generation ramp at the time of sudden fall and rise in demand during the event. The details of the ramping exercise carried out by hydro generators of northern and western region are enclosed at **Annexure-2.3**.

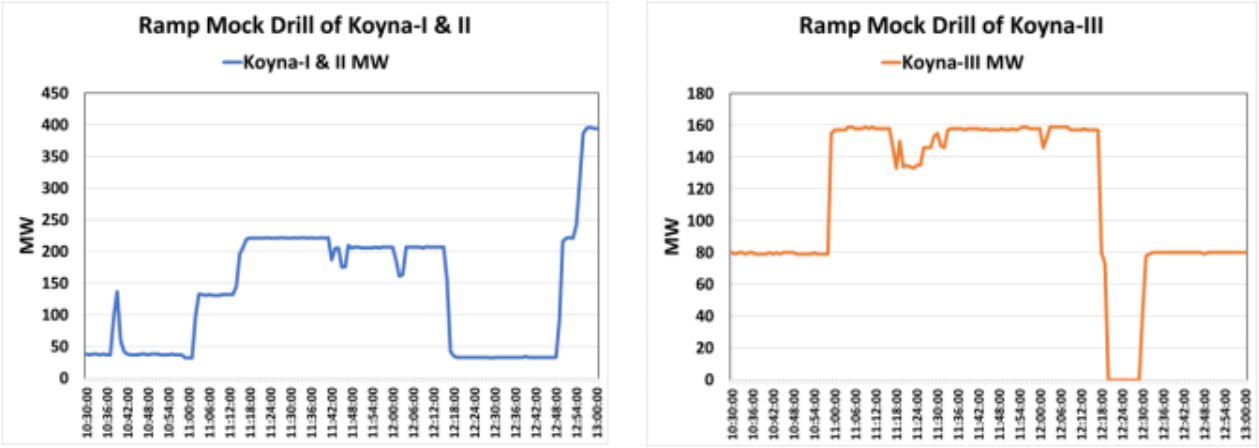


Figure 8: Koyna HEP Ramp Mock Drill Exercise

The detailed operational plan viz. 5 minute schedule, droop setting modification, different stages of operation were also finalized on 4th and 5th April 2020 by RLDCs with hydro generators. The 5 minute schedule for northern region hydro generators is given below:-

Time Block	20:40-20:45	20:45-20:50	20:50-20:55	20:55-21:00	21:00-21:05	21:05-21:10	21:10-21:15	21:15-21:20	21:20-21:25
Total_NR	9346	9253	7968	3692	2662	2662	6717	9158	9346
Chamera-I	534	534	450	54	54	54	450	534	534
Chamera-II	98	98	98	10	10	10	98	98	98
Chamera-III	228	172	116	21	21	21	116	172	228
Dhauliganga	276	240	140	40	40	40	140	240	276
Dulhasti	384	384	330	39	39	39	330	384	384
Parbati-III	130	130	80	10	10	10	80	130	130
Salal	690	690	615	288	36	36	363	690	690
NJPC	1482	1482	1288	1094	900	900	1191	1482	1482
Rampur	414	414	360	306	252	252	333	414	414
Tehri	760	760	680	245	100	100	535	760	760
Koteshwar	760	760	680	245	100	100	535	760	760
Koldam	792	792	696	360	120	120	360	696	792
Bhakra	1089	1089	823	270	270	270	823	1089	1089
Dehar	640	640	640	560	560	560	640	640	640
Pong	180	180	120	0	0	0	120	180	180
KWHEP	889	888	852	150	150	150	603	889	889

Table 1: Five minute schedule finalized for Northern Region Hydro Generators

The detailed operational plan for hydro plants with different stages of operation was also prepared. As per the plan, hydro power plants were to operate in three stages i.e. to minimize generation in first, second, third or more units with frequency touching 49.95 Hz, 50.00 Hz and 50.05 Hz respectively w.e.f. 20:50 hrs to 21:05 hrs. Similarly, generation was to be maximized in first, second, third or more units with frequency touching 50.05 Hz, 50.00 Hz and 49.95 Hz respectively w.e.f. 21:10 hrs to 21:25 hrs.

The operating plan with respect to change in frequency issued by NHPC Ltd. is given below. Similar operating plans (for the hydro power plant operators) were prepared by the respective generating companies in consultations with SLDCs/RLDCs.

Time Block (5-min)	Grid Freq. (Hz)	Load variation
2050 to 2055 hrs	50.00	Ramp Down ONE Unit to Minimum load
2055 to 2100 hrs	50.05	Ramp Down SECOND Unit to Minimum load
2100 to 2105 hrs	50.10	Ramp Down THIRD & MORE Units to Minimum load
2110 to 2115 hrs	50.10	No Ramp Up, keeping watch on frequency
	50.05	Ramp Up ONE Unit to Full load
	50.00	Ramp Up SECOND Unit to Full load
	49.95	Ramp Up THIRD & MORE Units to Full load
2115 hrs onwards		As per RLDC schedule

Table 2: Operating Plan for Hydro Power Plants by NHPC Ltd.

2.3.3 Directions to Transmission Licensees

Specific directions were given to concerned transmission licensees before the event to operate the STATCOMs and SVCs in voltage control mode with reference voltage being 1 PU. Further, detailed instructions were also given for revision in settings of FACTS devices.

S.No.	Element Name	Original Settings	Settings Kept on 5-Apr-20
1	MSR-1,2 (125 MVAR)	In : 1.03pu, 5 sec Out : 0.99pu, 5 sec	In : 1.00pu, 5 sec Out : 0.99pu, 5 sec
2	STATCOM-1,2 (±2x100MVAR)	Up set : 1.03pu Dn set : 0.97pu Slope : 2%	Up set : 1.00pu Dn set : 0.97pu Slope : 2%
3	MSC-1 (125 MVAR)	In : 0.97pu, 5 sec Out : 1.01pu, 5 sec	In : 0.97pu, 5 sec Out : 0.99pu, 5 sec

Table 3: Original and Revised Settings of STATCOM at Gwalior

2.3.4 Cross Border Support from Neighboring Countries

Presently, Indian grid is synchronously connected with Bhutan along with asynchronous connection with Nepal, Bangladesh and Myanmar. The grid operators of these neighboring countries were briefed about the #9pm9min event and possibility of cross

border support especially through the reduction in hydro generators (connected with Indian grid) in Bhutan and modulation of HVDC Bheramara (Bangladesh) during the event was requested. Acknowledging the challenges involved in managing this unprecedented event, the National Grid Operators of all the neighboring countries assured their full cooperation in managing the #9pm9min event.

2.3.5 Coordination Meeting by Ministry of Power, Government of India

During the preparation phase of the event i.e. 3rd, 4th and 5th April 2020, multiple meetings were held at the level of Hon'ble Minister of State for Power (Independent Charge) (MOSP), Secretary to the Government of India, Ministry of Power, Government of India with all the power sector entities to monitor the overall preparedness for event and provide necessary guidance and support for successful management of the event. The details of the meeting are given below.

Date	Time in hrs	Participants
3rd April 2020	1100	MOSP, Secretary (MoP) & CMDs of Gencos, POWERGRID, POSOCO
3rd April 2020	2100	Secretary (MoP) & CMDs of Gencos, POWERGRID, POSOCO
4th April 2020	1100	MOSP, Secretary (MoP) & CMDs of Gencos, POWERGRID, POSOCO
4th April 2020	1600	Secretary (MoP) & CMDs of Gencos, State Power Secretaries, POWERGRID, POSOCO
4th April 2020	1800	MOSP, Secretary (MoP) & CMDs of Gencos, POWERGRID, POSOCO
5th April 2020	1200	MOSP, Secretary (MoP) & CMDs of Gencos, POWERGRID, POSOCO

Table 4: Meetings organized by the MoP for the 5th April Lights off event

2.4 Preparation for Extreme Scenarios

Though the estimated demand reduction during the event was 12-15 GW, the preparation was carried out for the extreme scenario (i.e. for much more demand reduction than anticipated) considering the uncertainty in demand reduction due to switching off of additional appliances by households out of fear of equipment damage. The details of managing the demand reduction from various resources is as under:-

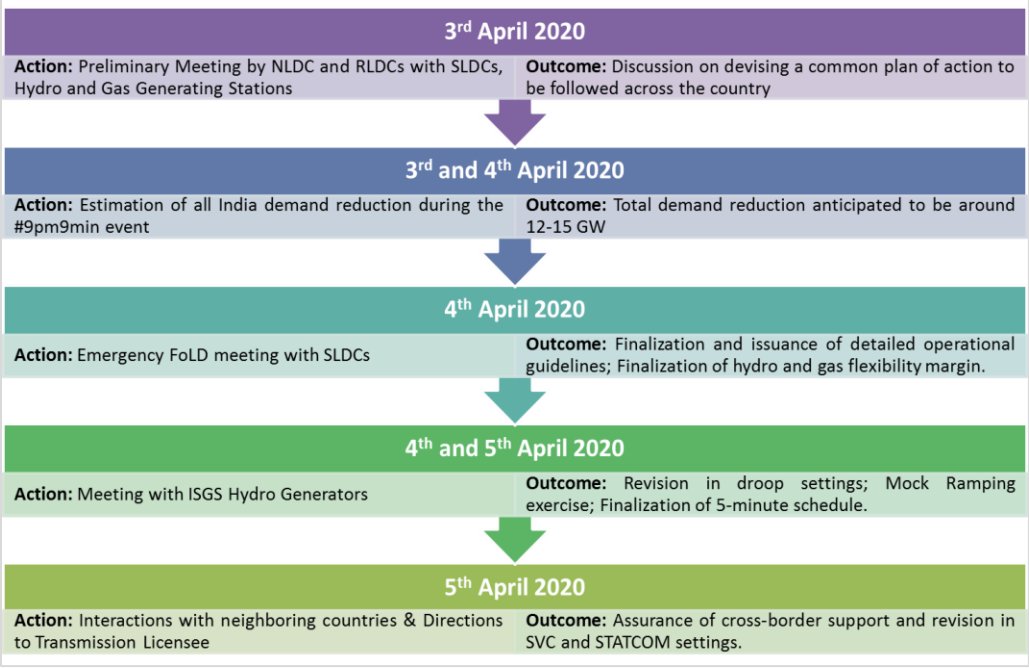
a) Operating margin of around 21000 MW was identified in hydro and gas generation resources across the country after deliberations with SLDCs and ISGS hydro and gas generating plants. This operating margin of 21000 MW doesn't include all the state hydro and gas generators and therefore, some extra margin from these excluded plants was also expected. Further, many hydro stations assured to provide additional support than the declared flexibility margin as per the advisory issued by NLDC.

b) Enabling of over-frequency setting of wind generators ensured (tripping wind turbines if frequency rose beyond 50.20 Hz) that relief of 2000 -4000 MW will be achieved from these resources.

c) As variations in frequency were expected to be in the range of 49.50 Hz to 50.50 Hz during the event. The advisory provided for keeping the frequency below 49.90 Hz prior to the start of demand reduction. The 0.60 Hz frequency cushion (50.50 – 49.90 Hz) would have provided virtual relief of the order of 4800 MW considering power number of 8000 MW/Hz.

Thus, against an anticipated reduction in demand of the order of 12-15 GW, the operating plan had a provision of 29 GW as mentioned above excluding relief from thermal generation.

The day-wise major actions taken in preparation of the event are summarized below.



2.5 Implementation of Preparatory Measures on 5th April 2020

Considering the short time-frame of the event, it was of utmost importance to implement the planned preparatory measures prior to the event and keep the system in the best possible condition for the event. Accordingly, in line with the detailed guidelines issued by POSOCO, following preparatory measures were implemented before the start of lights off event on 5th April 2020.

a) All ISGS hydro stations were advised by respective RLDCs to vary generation as per the detailed procedure finalized in the meeting held on 4th April 2020.

b) The confirmation about change of governor droop settings at hydro units was taken.

c) Instructions were issued by RLDCs to ISGS/State wind generators to enable the over-frequency settings i.e. automatic disconnection of the incoming feeders from wind generators in case of frequency rising beyond 50.20 Hz.

d) A dedicated SCADA display at NLDC control room was prepared for monitoring the generation and reserve availability in Hydro and Gas generating plants identified as flexible resources to manage the sharp variation in demand during the event.

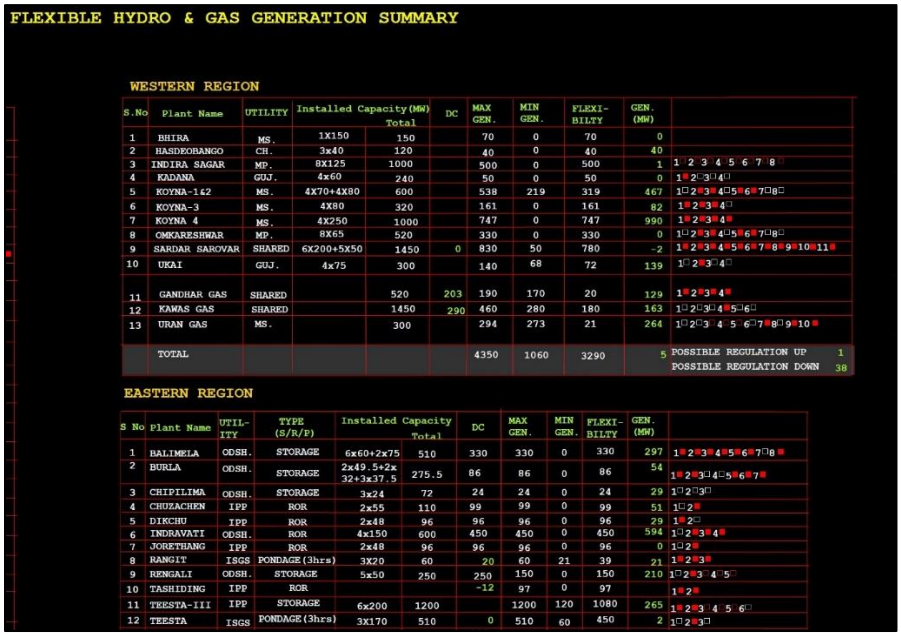


Figure 9: Dedicated SCADA Display for tracking Hydro and Gas Generation

e) Security Constrained Economic Despatch was stopped from 18:00 hrs onwards till rest of the day to keep sufficient margins in inter-regional corridors and generating stations.

f) The units (GTs) of gas based stations under reserve shutdown were brought on bar in open cycle mode of operation by 18:30 hrs. The gas generation was also maximized by 20:50 hrs to achieve the desired fast generation reduction during the event.

g) The scheduling of hydro resources was optimized with the objective of getting maximum hydro generation prior to the event. For this, the hydel energy was first conserved during the evening peak demand hours and schedule of thermal generators was modulated to compensate for the same. Subsequently, after the evening peak demand at 19:20 hrs, the thermal generation was gradually reduced with proportionate increase in hydro generation. The changes in generation scheduling are evident from the generation stack comparison given below.

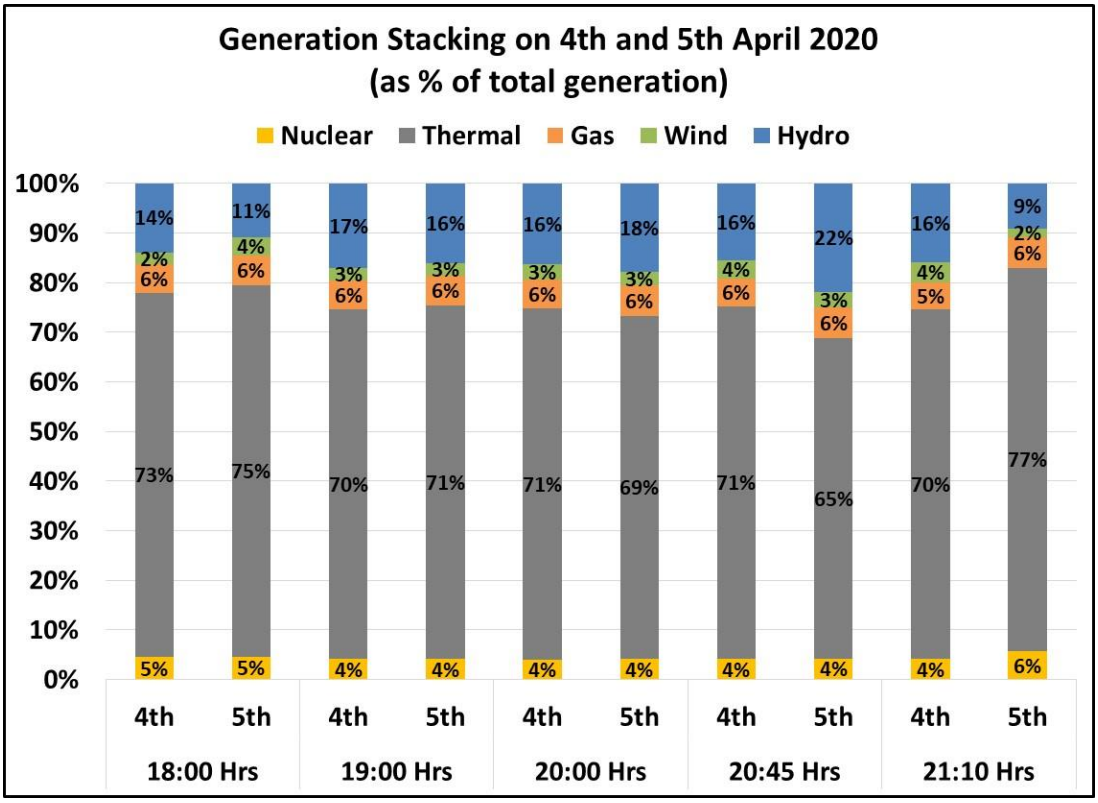


Figure 10: Generation Stack Comparison for 4th and 5th April 2020

The maximum hydro generation recorded during the past one week before the event was approx. 21500 MW. However, with above scheduling exercise, hydro generation of 25559 MW was achieved at 20:45 hrs of 5th April 2020.

h) In anticipation of high frequency at the time of sudden reduction in demand, the frequency was maintained on the lower side **(49.816 Hz at 20:45 hrs)** before the start of the event (as per the operational plan). Total RRAS (Reserves Regulation Ancillary Services) down of 3500 MW was applied between 20:30 hrs and 21:00 hrs to maintain the frequency on the lower side of IEGC band. Further, in anticipation of sharp rise in demand after the event, RRAS Up instruction of 3000 MW was also dispatched in advance. The details of RRAS dispatched prior to the event are tabulated below.

S. No.	RRAS Dispatch Quantum (+) Up/(-) Down	Time Period
1.	-1500 MW	20:00 hrs to 21:00 hrs
2.	-3500 MW	20:30 hrs to 21:00 hrs
3.	+3000 MW	21:00 hrs to 22:15 hrs

Table 5: RRAS Dispatch Details

i) Further, in order to avoid high voltages at the time of sudden reduction in demand, the voltages prior to the event were maintained on the lower side. Following actions were taken before the event for voltage control.

- Total 180-200 transmission lines of voltage level 400 kV and above (HVAC and HVDC) were kept open for voltage control.
- Bus and Switchable Line Reactors were taken in service, wherever required.
- SVCs at 400 kV Kankroli, Kanpur, New Wanpoh and Ludhiana S/s were taken in voltage control mode with reference voltage of 400 kV. Instructions were also issued to modify the settings of STATCOMs as per requirement.

- All the generating plants were advised to absorb/generate reactive power as per requirement. Wind turbine generators were advised to operate in voltage control mode instead of constant power factor mode.
- SLDCs/DISCOMs were advised to switch off capacitor banks at distribution level.

The sequence wise advance actions taken on 5th April 2020 are given below.

Advance Measures on 5th April 2020	**Mock exercise on Hydro Ramping carried out on 4th April 2020 night and 5th April 2020 morning.**
	Droop settings of Hydro Units revised from existing level of 4-5% to 1-2%.
	Automatic disconnection of wind generators in case of frequency rising beyond 50.20 Hz enabled.
	Schedule of Hydro generation optimized for maximizing hydro generation prior to the lights off event.
	Bus and Switchable Line Reactors taken in service as per requirement. SVCs taken in voltage control mode. Instructions issued to modify the settings of STATCOMs as per requirement.
	Around 200 transmission lines of voltage level 400 kV and above kept open for voltage control.
	Gas based units under reserve shutdown brought on bar by 18:30 Hrs of 5th April 2020.
	Thermal and Hydro generation ramped up till 19:20 Hrs to meet the evening peak demand.
	Thermal generation reduced gradually after 19:20 Hrs with proportional increase in hydro generation. Hydro Generation maximized by 20:45 Hrs and thermal generation brought down near technical minimum level.
	Units at Pumped Storage Hydro Plants (Nagarjuna Sagar and Kadamparai) taken into pump mode.
	RRAS (Reserves Regulation Ancillary Services) down applied between 20:30 Hrs and 21:00 Hrs to maintain frequency on the lower side of IEGC band.

The details of actual operations during the lights off event are provided in next section.

3 Operations during the Lights Off event

Due to the diverse and distributed actions of the households across the country, the effects of lights off event started few minutes before the scheduled time of the event. The all India demand started reducing sharply from **116887 MW at 20:45 hrs** and touched minimum of **85799 MW at 21:10 hrs.** However, maximum ramp down was recorded at 21:00 and 21:01 hrs. This sudden fall in demand of **31089 MW** was managed effectively with matching generation back down in hydro, thermal, gas and wind generators across the country. The details of demand and source wise generation along with maximum ramp in MW/min observed between 20:45 hrs to 21:10 hrs is tabulated below:-

Description	Generation/Demand (MW)			Reduction from A to B (MW)	Increase from B to C (MW)	Max. Ramp MW/Min. A to B (-)	Max. Ramp MW/Min. B to C
	20:45 hrs (A)	21:10 hrs (B)	21:30 hrs (C)				
Hydro	25559	8016	18923	**17543**	**10907**	**2728**	**1977**
Thermal	75277	68037	75661	**7240**	**7624**	**1109**	**637**
Gas	7305	5355	7175	**1950**	**1820**	**339**	**226**
Wind	3564	1566	2527	**1998**	**961**	**580**	**164**
All India Demand	116887	85799	108808	**31089**	**23009**	**4197**	**3015**

Table 6: All India Demand and Generation Summary during the event

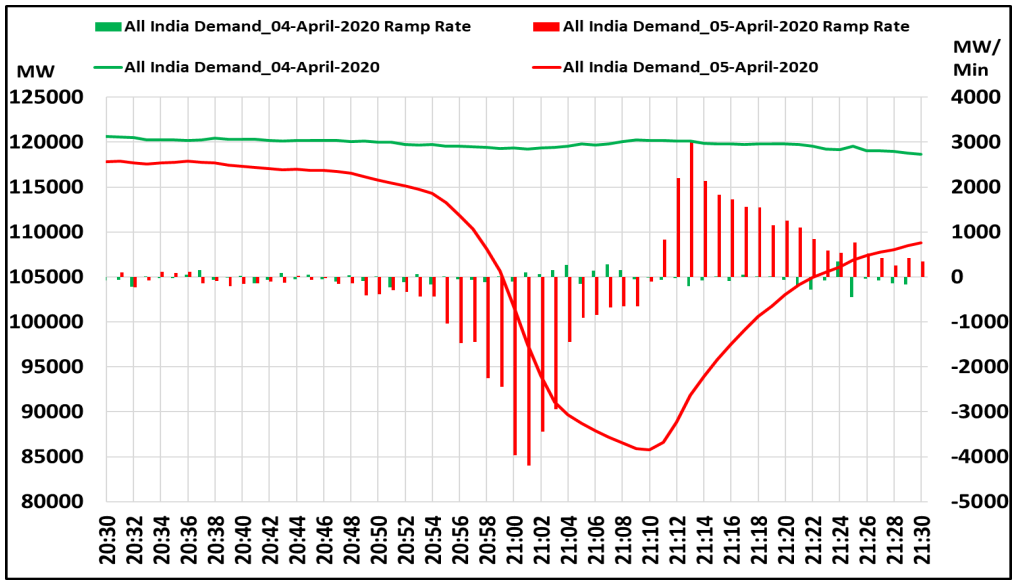


Figure 11: All India Demand Trend during the lights off event

The grid frequency during the event remained in the range of **50.26 Hz to 49.70 Hz** with maximum and minimum frequency of **50.259 Hz and 49.707 Hz** recorded at **21:08 hrs and 20:49 hrs** respectively.

The all India demand started picking up at 21:10 hrs and settled around **114400 MW** at **22:10 hrs.** This recovery of load was again managed with increase in hydro, thermal, gas and wind generators as shown in Table-6 above. As planned, thermal power plants under RRAS (Reserve Regulation Ancillary Services) were given the instructions through ancillary dispatch mechanism to provide additional 3000 MW generation support starting from 21:00 hrs (thermal generating stations were expected to start ramping up from 2105 hrs as per advisory issued). The hydro and gas generation which again provided the required high rate of change of generation during the sharp rise in demand was gradually replaced with thermal generation by 22:30 hrs.

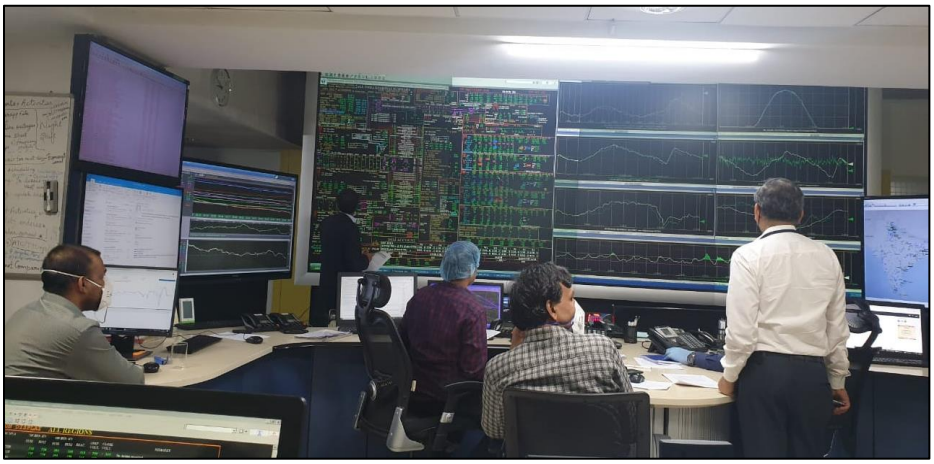


Figure 12: Operations from NLDC Control Room on 5th April 2020

During the entire period of the event, all the major Hydro and Gas stations were taken online telephonically or through video conferencing by real time grid operators at RLDCs and NLDC and one to one continuous communication was in place to ensure change in generation w.r.t. demand and frequency.

The grid frequency touched 50.20 Hz at 21:01 hrs and with the implementation of over frequency settings for wind generators i.e. automatic disconnection of generation in case of frequency going beyond 50.20 Hz, relief of around 1635 MW was received from wind generators between 21:01 hrs to 21:10 hrs from automatic/manual tripping of feeders.

Voltages at major 765 kV and 400 kV nodes were maintained within limits. The maximum and minimum voltages recorded in the entire grid during the event are tabulated below.

Voltage level	Maximum		Minimum	
	Voltage (kV)	Station	Voltage (kV)	Station
765 kV	794	Ektuni	725	Fatehpur
400 kV	434	Kalwa	387	Arambag

Further, no undesirable tripping or untoward incident was observed during the lights off event.

During the entire period of the event, the leadership team of POSOCO was present in the National and Regional Despatch Centers for smooth coordination and management of the event. Similarly, at all SLDCs, all the top officials from SLDCs/STUs/State Energy Departments were present in the respective control centers.

The Hon'ble Minister of State for Power (I/C) with other senior officers of Ministry of Power, Government of India was also monitoring the whole event from National Power Monitoring Center (NPMC) located at Ministry of Power, Shram Shakti Bhawan, New Delhi.

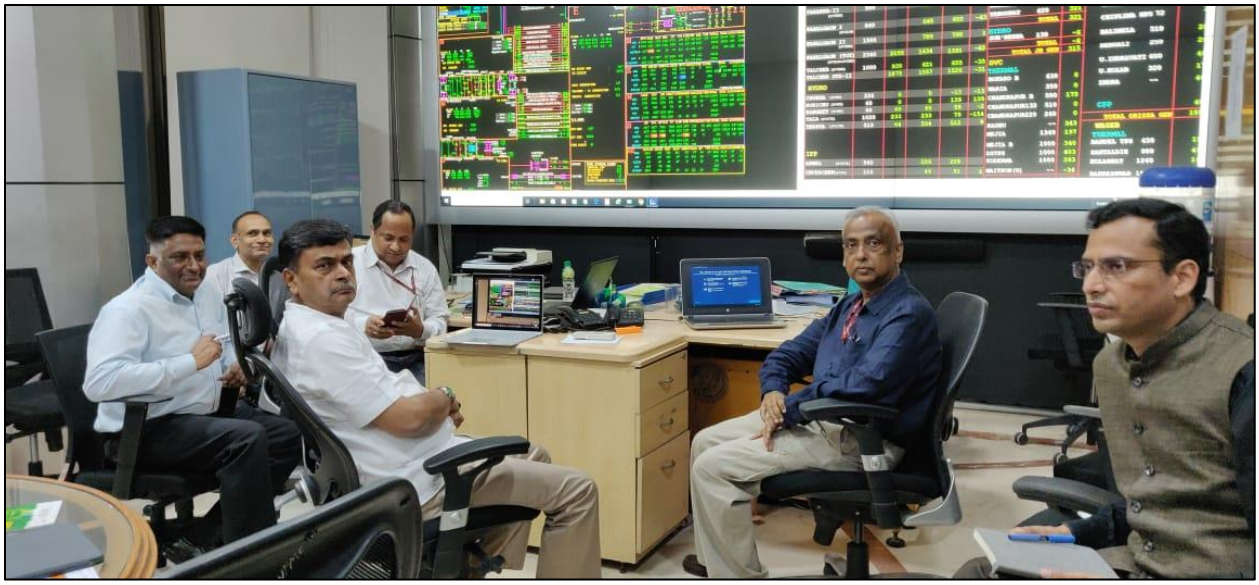


Figure 13: Hon'ble Minister of State for Power (I/C) at NPMC on 5th April 2020

4 Reports by State Load Despatch Centers on the Lights Off Event

Post event, a FOLD meeting was held on 09th April 2020 wherein the wholehearted and synchronized actions and support from all the SLDCs, generating stations, transmission companies and DISCOMs were appreciated and all the SLDCs were requested to share their experiences. SLDCs were also requested to submit a detailed report of the event covering analysis of higher than anticipated reduction in demand. It was suggested that SLDCs through respective DISCOMs shall analyze the granular smart meter data of either from smart city projects or other residential area load.

Most of the SLDCs have submitted their reports on lights off event. As gathered from the reports, major actions taken by the SLDCs prior to the event are as under:-

a) Issuance of detailed advisory on power system operation during the event to respective stakeholders.
b) Issuance of instructions to concerned authorities for keeping the street lighting load, supply to essential services premises on during the event.
c) Issuance of instructions to generators to generate/absorb reactive power as per requirement.
d) Switching off capacitors at distribution level for voltage control.
e) Optimizing the tap position of transformers to maintain voltages.
f) Opening of transmission lines and switching on reactors for voltage control.
g) Avoiding switching operations between 20:00 hrs to 22:00 hrs.

On 5th April, during the evening hours, the demand of southern region was less by approx. 2000 MW from the previous day due to inclement weather in most of the southern region states. Apart from southern region constituents, J&K, Chhattisgarh, and Mizoram observed reduced demand of approx. 400 MW, 100 MW, 8 MW due to thunder showers/rains.

In order to compensate for the reduction in demand, shifting of loads (around 2000 MW) was carried out by state of Telangana and Andhra Pradesh (AP). Details are given at figure-14 below.

During the event, the SLDCs endeavored to balance load-generation in close coordination with generators, RLDCs and NLDC. Further, no unintended tripping has been reported by any SLDC during the lights off event.

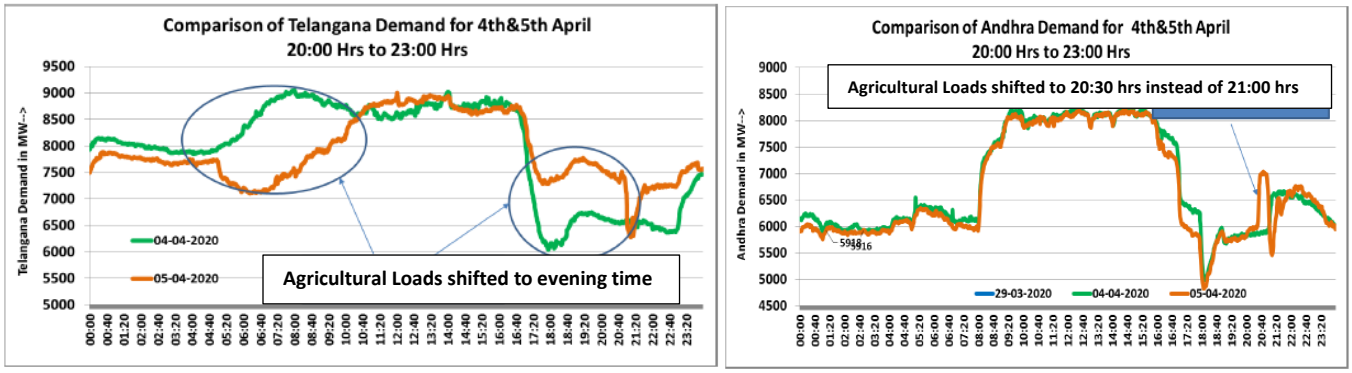


Figure 14: Telangana and Andhra Pradesh – Load Shifting on 5th April 2020

The brief of the reports submitted by the SLDCs is enclosed at **Annexure-4.1**. The individual SLDC reports would be available separately on the website of Forum of Load Despatchers (FOLD).

5 Demand Variation

A sharp reduction in All India demand was observed between 20:45 hrs to 21:10 hrs. Total fall in demand during this period was **31089 MW** [6]with the demand falling from **116887 MW** at 20:45 hrs to **85799 MW** at 21:10 hrs. The all India demand started picking up at 21:10 hrs and settled around **114400 MW** at **22:10 hrs.** Maximum ramp down and ramp up rates of all India demand during the lights off event was **4196 MW/Min** and **3015 MW/Min**.

Among regional demands, the maximum reduction **9730 MW** was observed in Northern region followed by **8464 MW** in Western region, **6136 MW** in Eastern region, **5978 MW** in Southern Region, and **781 MW** in North-eastern region.

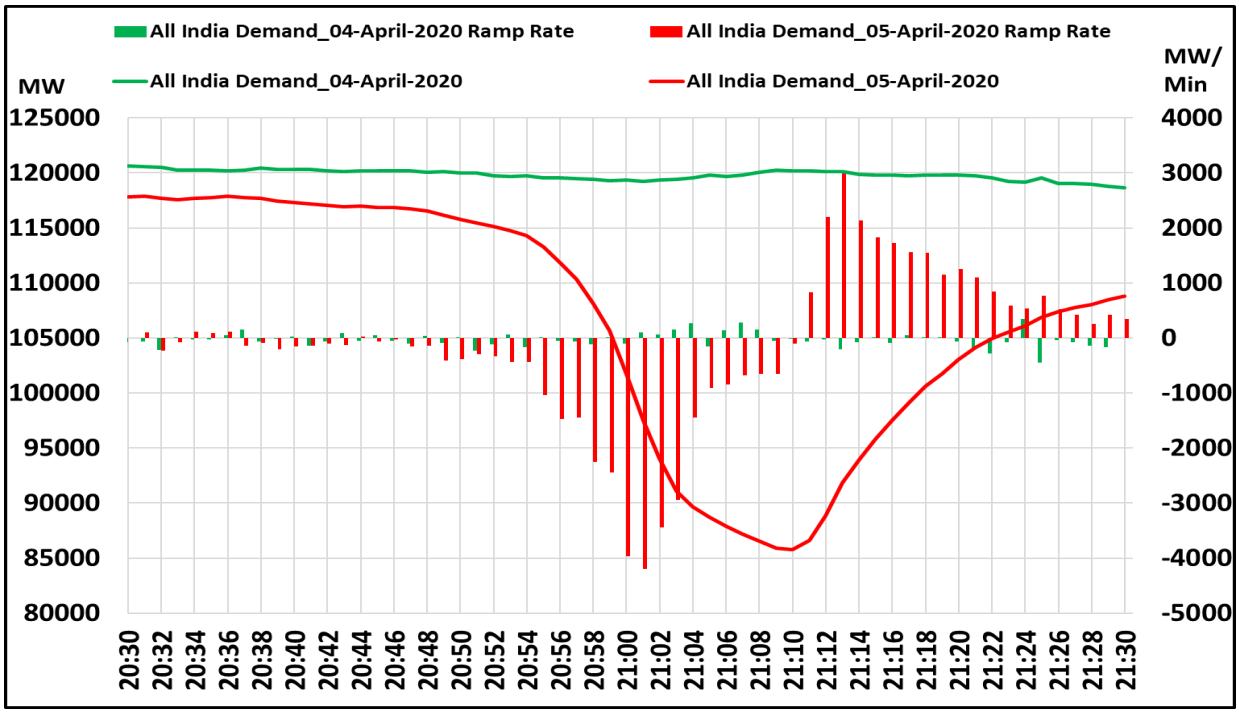


Figure 15: All India Demand during the event

The details of all India, Regional and State wise reduction in demand are tabulated below.

[6] *The actual demand reduction would be higher if the frequency corrected load is considered. Considering the 3% per Hz sensitivity of load to frequency, the corrected demand reduction figure comes out to be around 32180 MW.*

Demand Reduction Details of Lightning Event on 05th April 2020

S.No.	Region/ Entities	Demand at 20:45 hrs (a)	Demand at 21:10 hrs (b)	Actual Change in demand (c=a-b)	Percentage Change in demand (-c/a)	Maximum ramp up (MW/Min)	Maximum ramp down (MW/Min)
1	All India	116887	85799	31089	-26.6%	3015	4196
2	Northern Region	31791	22061	9730	-30.6%	834	1225
3	Western Region	32474	24010	8464	-26.1%	1063	1298
4	Southern Region	35012	29034	5978	-17.1%	527	1136
5	Eastern Region	15815	9679	6136	-38.8%	665	921
6	North Eastern	1796	1015	781	-43.5%	95	126
7	Chandigarh	115	82	33	-28.6%	4	5
8	Delhi	2022	1264	758	-37.5%	132	283
9	Haryana	3745	2790	955	-25.5%	143	118
10	Himachal	581	391	191	-32.8%	37	44
11	J&K	1602	1535	67	-4.2%	131	203
12	Punjab	3149	2402	746	-23.7%	83	138
13	Rajasthan	5794	3657	2136	-36.9%	146	278
14	Uttar Pradesh	13755	9140	4616	-33.6%	429	612
15	Uttarakhand	1028	800	228	-22.2%	77	100
16	Chhattisgarh	2879	1957	923	-32.0%	72	149
17	Daman	61	47	14	-23.2%	2	3
18	DNH	85	62	23	-26.8%	3	6
19	Gujarat	8674	6839	1835	-21.2%	144	249

Demand Reduction Details of Lightning Event on 05th April 2020

S.No.	Region/ Entities	Demand at 20:45 hrs (a)	Demand at 21:10 hrs (b)	Actual Change in demand (c=a-b)	Percentage Change in demand (-c/a)	Maximum ramp up (MW/Min)	Maximum ramp down (MW/Min)
20	Goa	311	213	98	-31.4%	12	18
21	Madhya Pradesh	7027	4883	2143	-30.5%	395	371
22	Maharashtra	13414	9964	3450	-25.7%	415	581
23	Andhra Pradesh	7017	5474	1543	-22.0%	205	340
24	Karnataka	6868	6066	803	-11.7%	210	224
25	Kerala	2687	2146	541	-20.1%	84	85
26	Pondy	206	148	58	-27.9%	6	7
27	Tamil Nadu	10046	7876	2170	-21.6%	214	392
28	Telangana	7374	6293	1081	-14.7%	161	201
29	Bihar	3719	1588	2131	-57.3%	183	395
30	DVC	1348	866	482	-35.8%	67	90
31	Jharkhand	1306	729	576	-44.2%	58	88
32	Orissa	2954	1701	1253	-42.4%	161	154
33	Sikkim	57	33	24	-42.0%	3	5
34	West Bengal	6224	4418	1806	-29.0%	208	308
35	Arunachal Pradesh	64	33	30	-47.3%	6	6
36	Assam	1097	572	525	-47.9%	58	80
37	Manipur	96	53	43	-45.0%	4	16
38	Meghalaya	190	152	38	-19.9%	28	39
39	Mizoram	63	55	7	-11.9%	2	3
40	Nagaland	110	66	44	-39.7%	7	11

Demand Reduction Details of Lightning Event on 05th April 2020							
S.No.	Region/ Entities	Demand at 20:45 hrs (a)	Demand at 21:10 hrs (b)	Actual Change in demand (c=a-b)	Percentage Change in demand (-c/a)	Maximum ramp up (MW/Min)	Maximum ramp down (MW/Min)
41	Tripura	167	83	84	-50.2%	13	14
Note: All Demand Figures are in MW							

Table 7: All India, Regional and State Demand Reduction Details

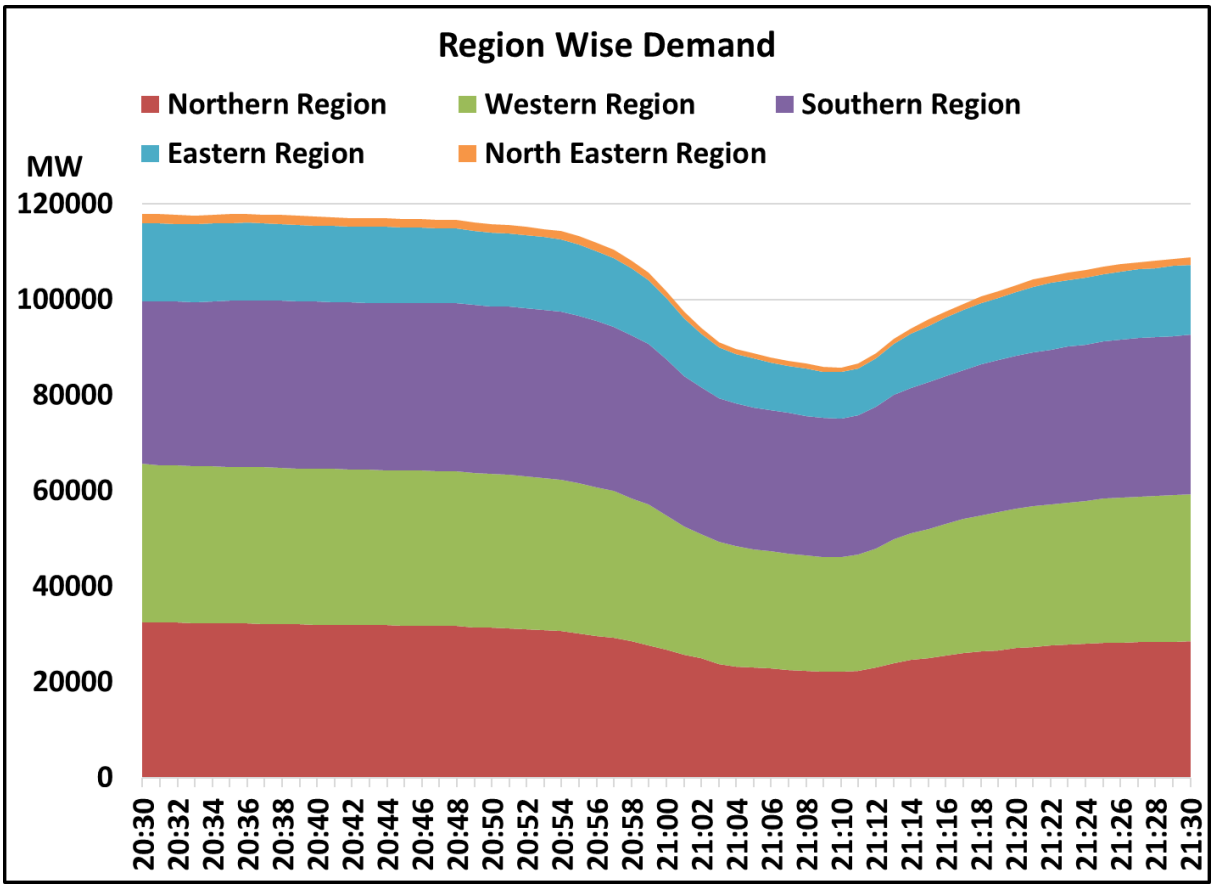


Figure 16: Stack Plot of Regional Demands during the event

The regional and state demand plots during the event are attached at **Annexure-5.1**. Further, the minute wise data of all India and regional demand during the event is enclosed at **Annexure-5.2.**

6 Inter-Regional and State Drawls

The inter-regional (IR) drawl patterns for all the regions are given below. From the drawl pattern, it could be observed that most of the regions tried to manage their generation corresponding to demand change in respective regions as there are small changes in inter-regional exchanges of regions (except for eastern region) during the event.

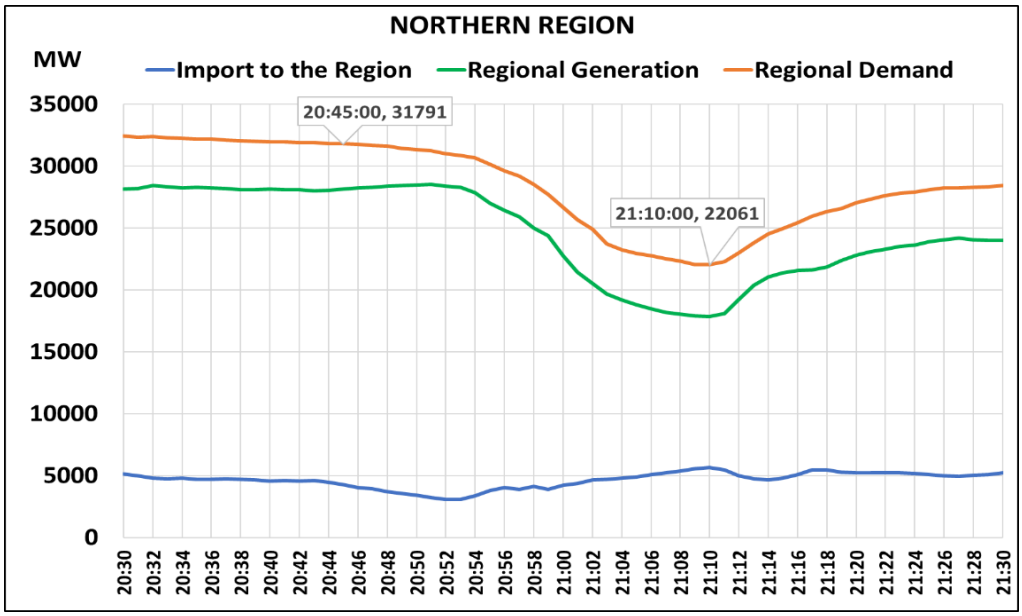


Figure 17: Northern Region – Inter-regional Drawl

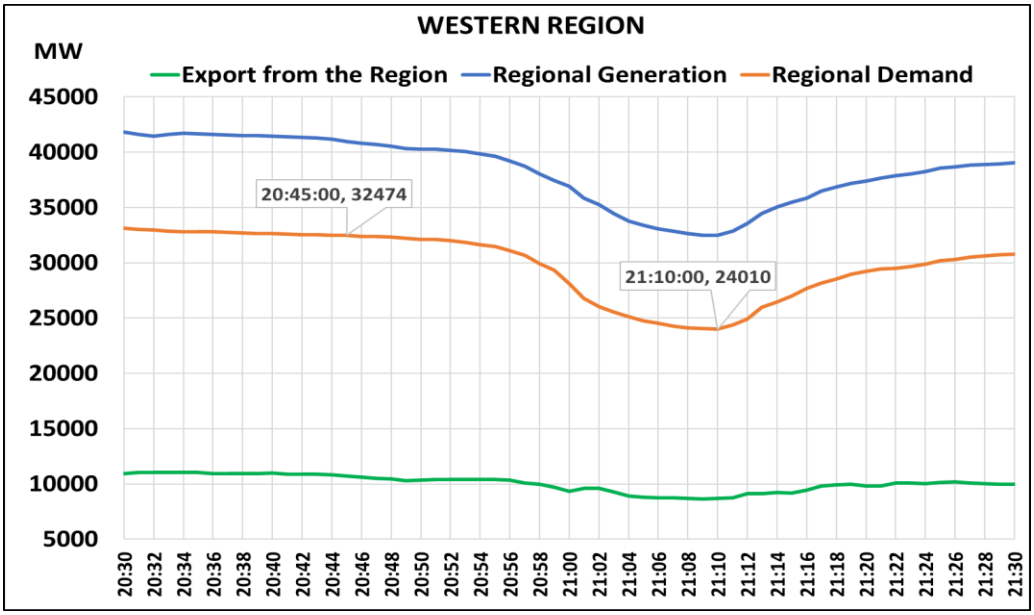


Figure 18: Western Region – Inter-regional Drawl

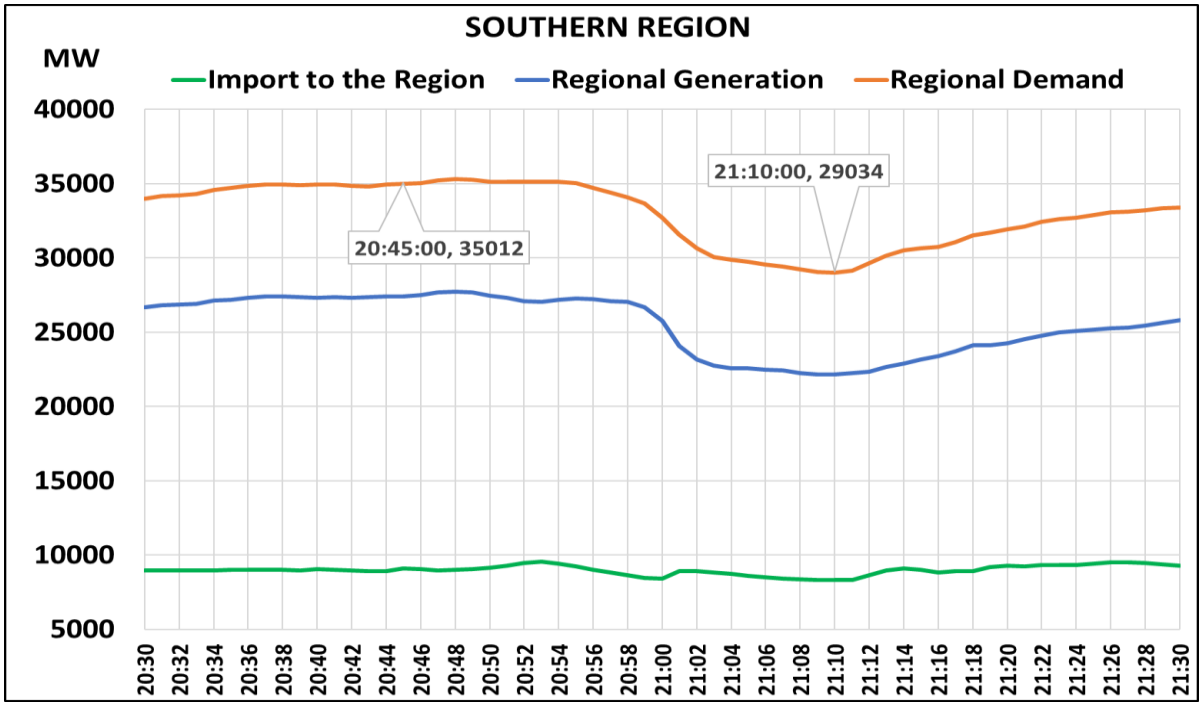


Figure 19: Southern Region – Inter-regional Drawl

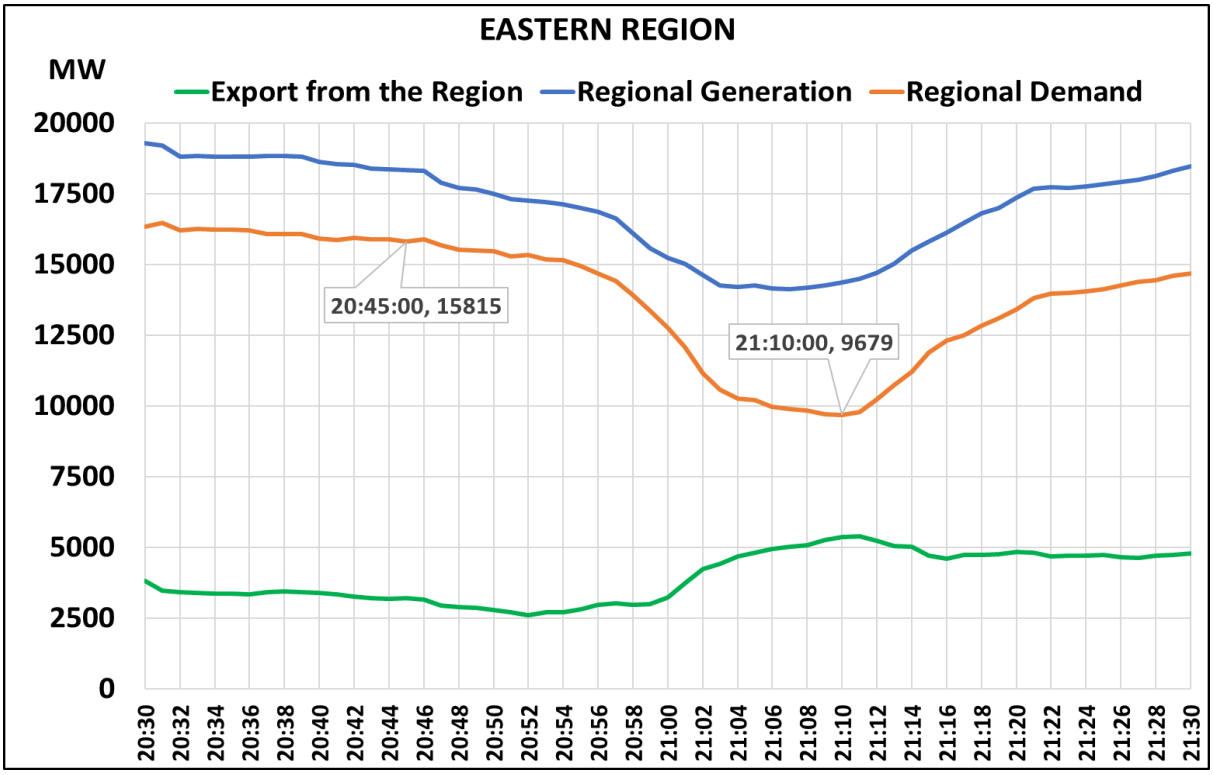


Figure 20: Eastern Region – Inter-regional Drawl

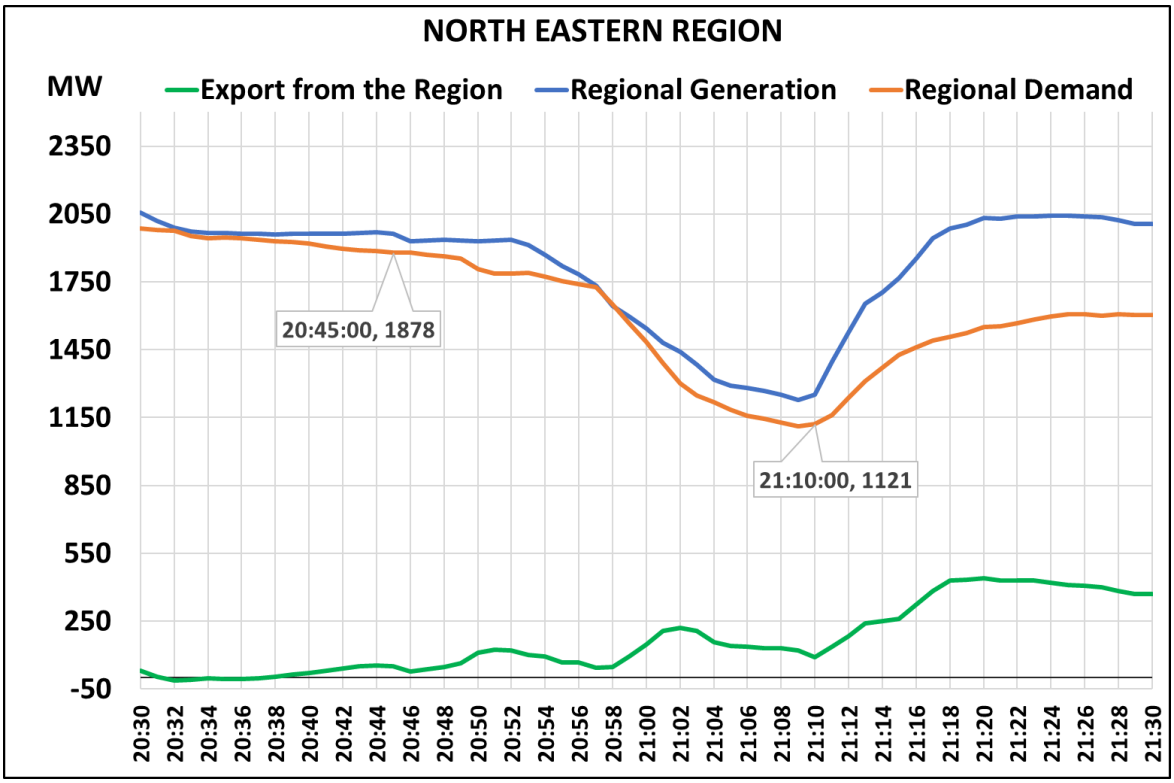


Figure 21: North Eastern Region – Inter-regional Drawl

The state drawl patterns during the event are attached at **Annexure-6.1**.

7 Generation Management

On the day of the event, fast ramping flexible resources (hydro and gas stations) were harnessed in addition to the coal-fired stations having low ramp rates to respond to the fast variation in demand. The units of gas based stations which were under reserve shutdown were brought on bar in open cycle mode of operation by 18:30 hrs. The gas generation was also maximized by 20:50 hrs to achieve the desired fast generation reduction during the event.

Further, the scheduling of hydro resources was optimized with the objective of getting maximum hydro generation prior to the event so that generation could be reduced matching with sharp fall in demand during the event. The maximum hydro generation recorded during the one week prior to the event was approx. 21500 MW. However, with above scheduling exercise and coordination with SLDCs, hydro generation of 25559 MW was achieved at 20:45 hrs of 5th April 2020. This maximization of hydro generation prior to event was achieved with corresponding reduction in thermal generation.

The fall in demand of **31089 MW** was managed effectively with the matching generation back down in hydro, thermal, gas and wind generators across the country. The details of generation reduction are as under:-

S.No	Description	Gen. at 20:45 hrs (a)	Gen. at 21:10 hrs (b)	Actual Change in Gen. (c=a-b)	Percentage Change in Gen. (-c/a)	Gen. at 21:30 hrs (d)	Maximum ramp up (MW/Min)	Maximum ramp down (MW/Min)
1	Thermal	75277	68037	7240	9.6%	75661	645	1123
2	Hydro	25559	8016	17543	68.6%	18923	1977	2728
3	Gas	7305	5355	1950	26.7%	7175	226	339
4	Wind*	3564	1566	1998	56.1%	2527	164	580
5	Nuclear**	4928	4981	-53	-1.1%	4942	49	47

All figures are in MW

** Ramp up/down figures include automatic/manual tripping of generators/lines connecting generators*

***No flexing duty was assigned to nuclear generating stations*

Table 8: Generation Management during the event

The trend of Thermal, Gas, Hydro and Wind Generation during the event is given below.

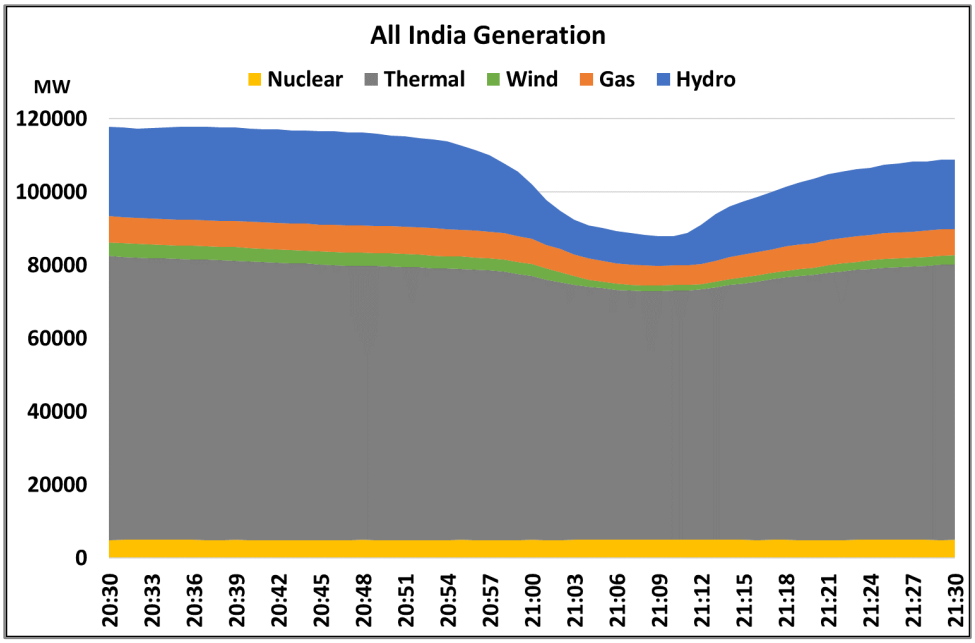


Figure 22: Coal, Lignite, Gas, Hydro and Wind Generation during the event

Generation reduction of 17543 MW between 20:45 hrs to 21:10 hrs (matching with demand reduction of 31089 MW during the same period) was achieved with hydro resources. This hydro generation was again ramped up from 8016 MW to 18923 MW from 21:10 hrs to 21:30 hrs to meet the increase in demand after the event.

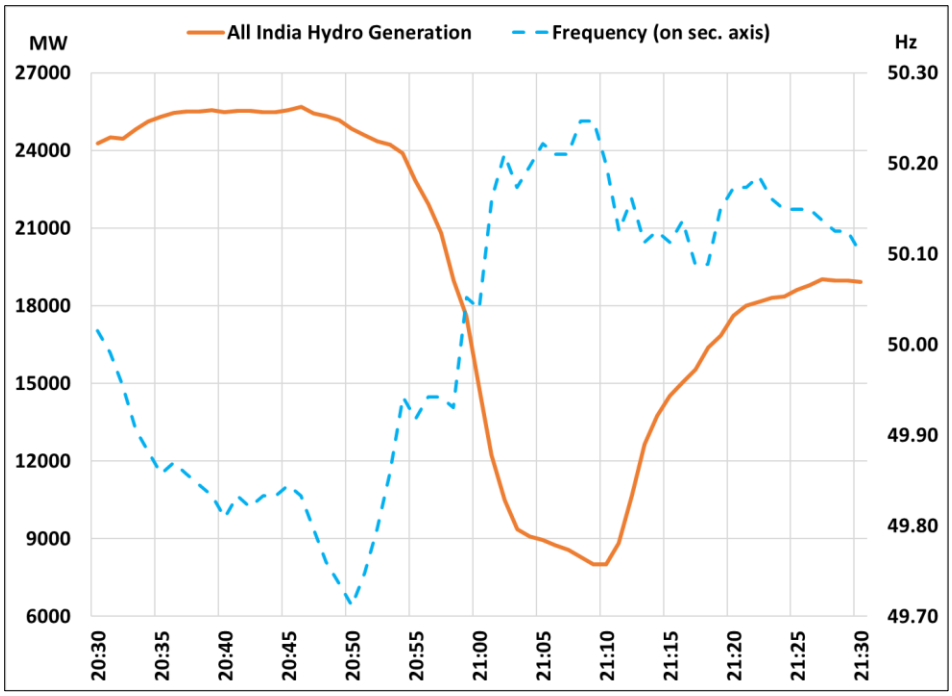


Figure 23: Variation in all India Hydro Generation

As per the detailed plan prepared with hydro generators, the generation in different units of each hydro plant was varied according to the change in demand and frequency during the time period of lights off event. The change in generation of different units of Nathpa Jhakri HEP (6x250 MW) during the event is given below. It could be observed from the figure 24 below that units- I and II have reduced the set point from 225 MW to 25 MW (0 to 10% range as mentioned in advisory issued by NLDC) at 20:50 hrs leading to the generation reducing within 4 minutes. The other four units continued to operate and provided primary response at the rate of 2% droop setting (25 MW reduction with 0.1 Hz rise in frequency) till 21:03 hrs. Subsequently, at 21:03 hrs, the set point of unit – III and IV was changes to 25 MW while units – V and VI continued to operate briefly close to the high vibration zone. At 21:10 Hrs, the set points of units I to IV was again increased to match the generation with rise in demand.

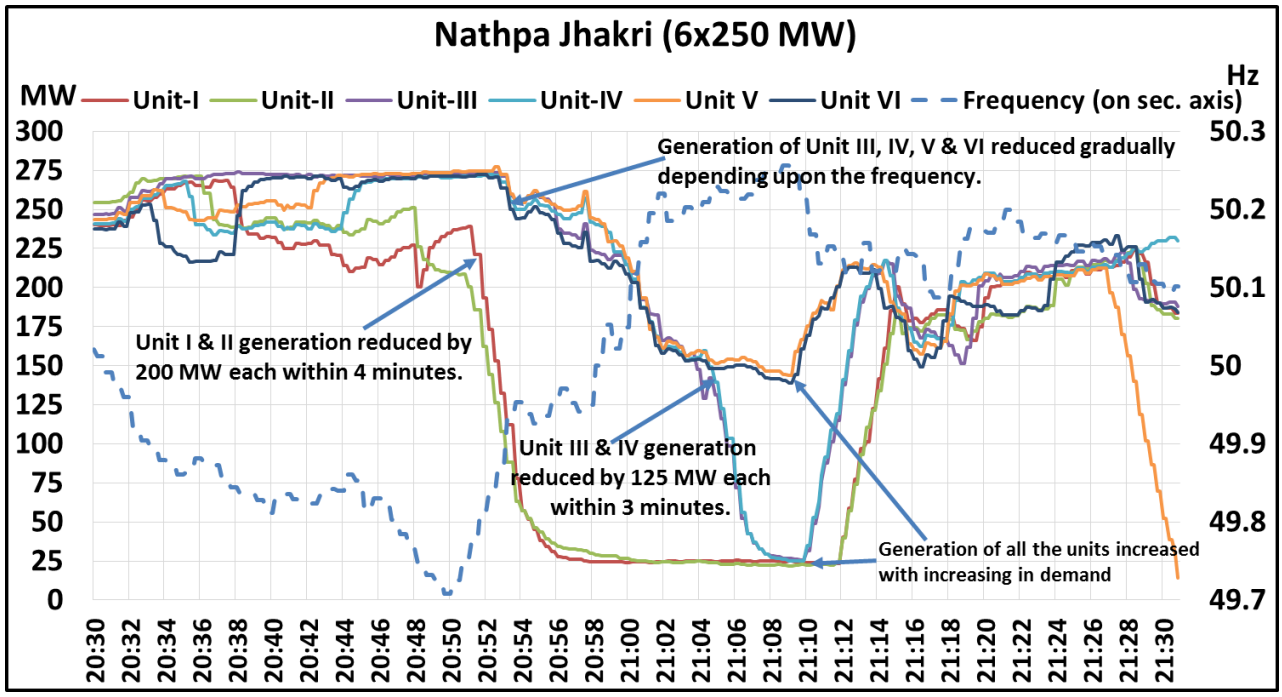


Figure 24: Variation of generation in different units of Nathpa Jhakri HEP

Total relief of 8190 MW was achieved through Thermal (7240 MW) and Gas (1950 MW) generation. None of the gas stations located on the gas grid have so far reported any issues in gas pressure variation during the event. The generation variation of thermal and gas generating stations on all India level is given below.

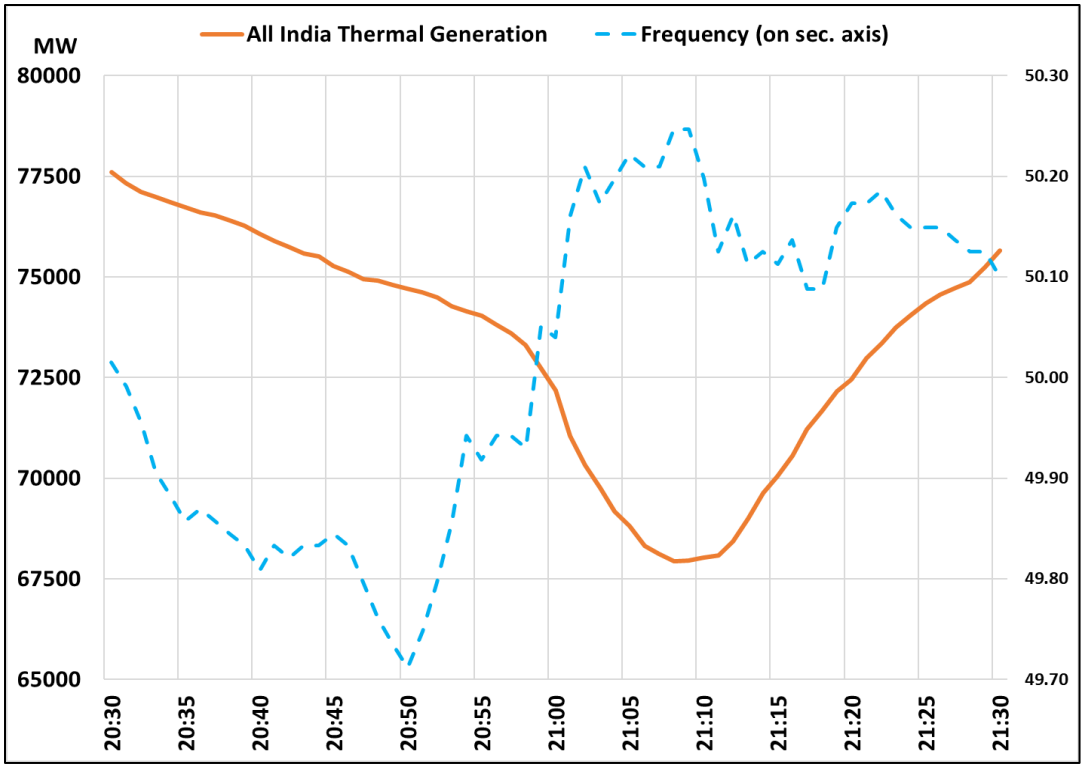


Figure 25: Variation in all India Thermal Generation

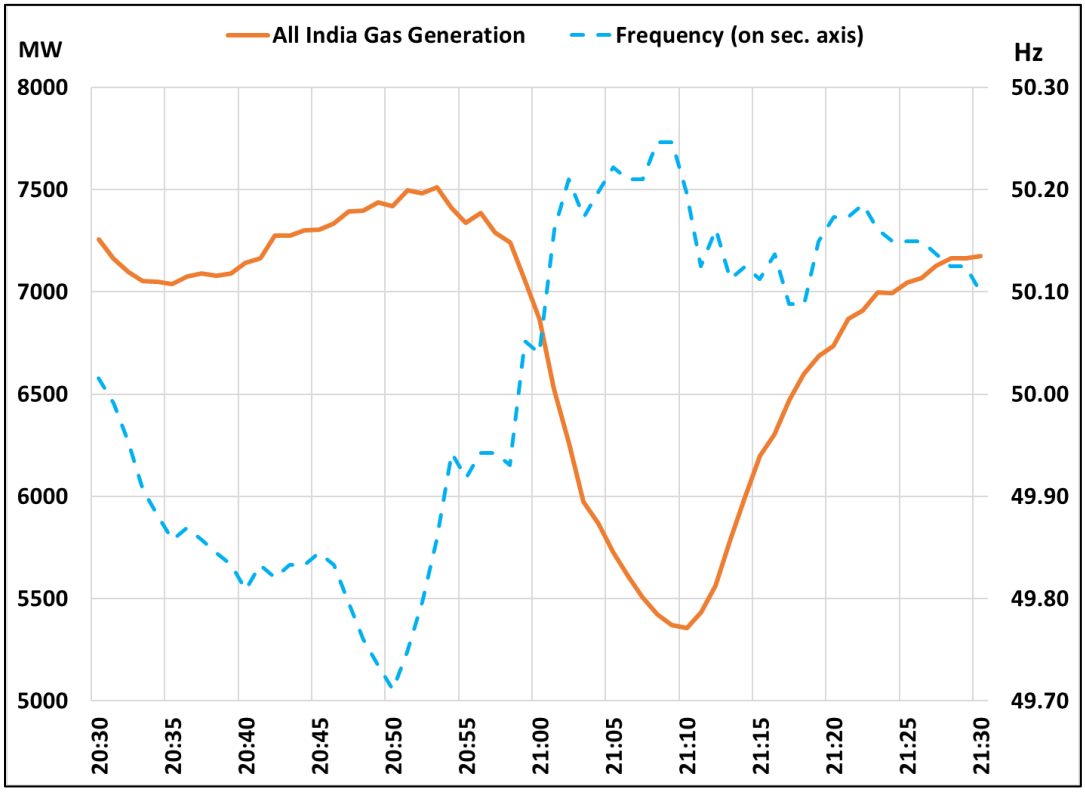


Figure 26: Variation in all India Gas Generation

Generation reduction of total 1998 MW between 20:45 hrs to 21:10 hrs was received from wind generation. The trend of wind generation during the event is given below.

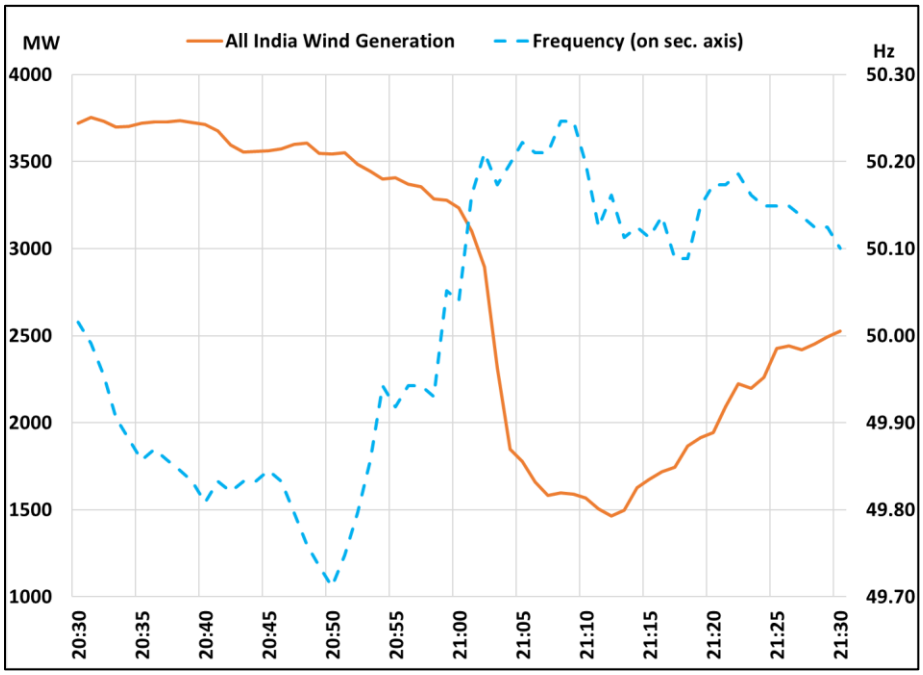


Figure 27: Variation in all India Wind Generation

Nuclear generating stations were not assigned any flexing duty during the event. The trend of nuclear generation during the event is given below.

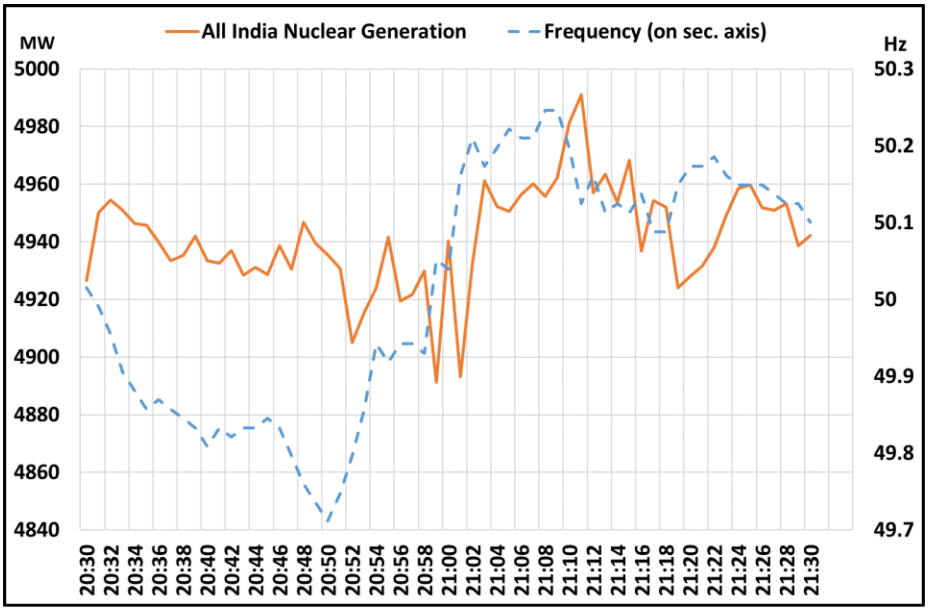


Figure 28: Variation in all India Nuclear Generation

The maximum rate of fall and rise in demand recorded during the event was **4196 MW/Min** and **3015 MW/Min** respectively. This rate of change in demand was managed with matching rate of change in generation sources. The maximum rate of change in generation was -**4312 MW/Min** and **+2839 MW/Min** with maximum ramp rate of **-2728MW/Min** and **+1977 MW/min** provided by hydro generators.

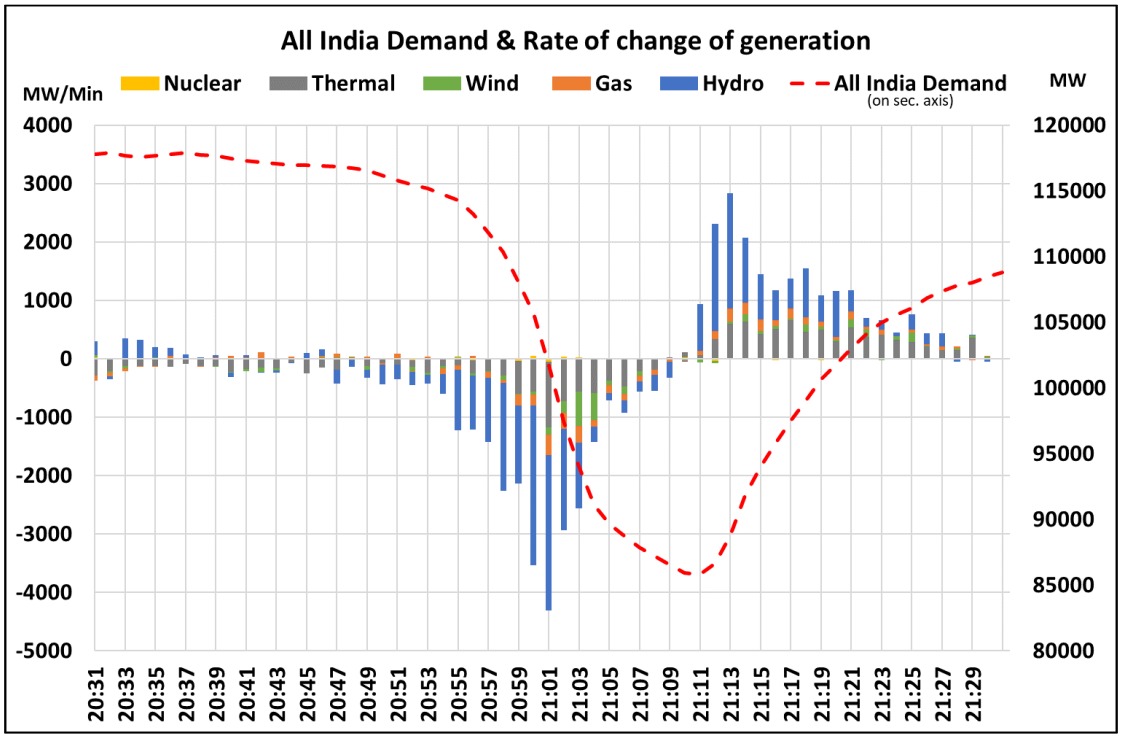


Figure 29: All India Demand vs Generation Ramp during the event

The regional and state generation pattern during the event is attached at **Annexure-7.1 to 7.4.** Further, the minute wise tabulation of source wise all India and regional generation during the event is enclosed at **Annexure – 7.5**.

8 Response of Pumped Hydro and Lift Irrigation Projects

During the event, 04 units of Nagarjuna Sagar PSP (4x110 MW) and 02 units (2x110 MW) of Kadamparai PSP were taken in pump mode. Initially, in order to keep frequency on lower side of IEGC band as planned, units at Nagarjuna Sagar and Kadamparai station were taken in pumping mode sequentially from 20:30 hrs. Later, with increase in frequency due to sudden reduction in demand, these units started drawing more power from the grid and reached respective peak capacity by 21:00 hrs. Total relief of around 650 MW was received from these two pumped[7] storage plants during the event.

The advisory issued by NLDC mentioned that during the buildup of demand after 21:09 hrs, units on pumping mode shall trip at 49.70 Hz. However, this requirement didn't arise during the event.

All four units of Purulia PSP (4X225 MW) were kept in generation mode prior to start of the event and the generation in the units was modulated with change in frequency during the event.

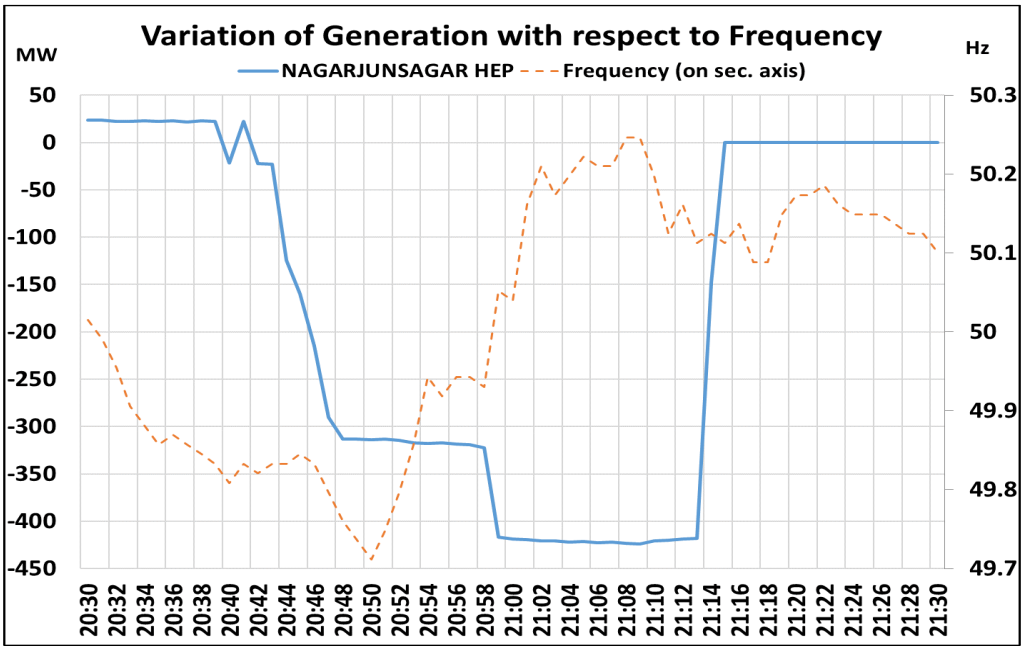


Figure 30: Nagarjunasgar PSP Generation during the event

[7] *Pumped Storage Plant means a system of generating electricity in which the electricity is generated during the peak hours by using water that has been pumped into upper reservoir during off-peak hours from the lower reservoir*

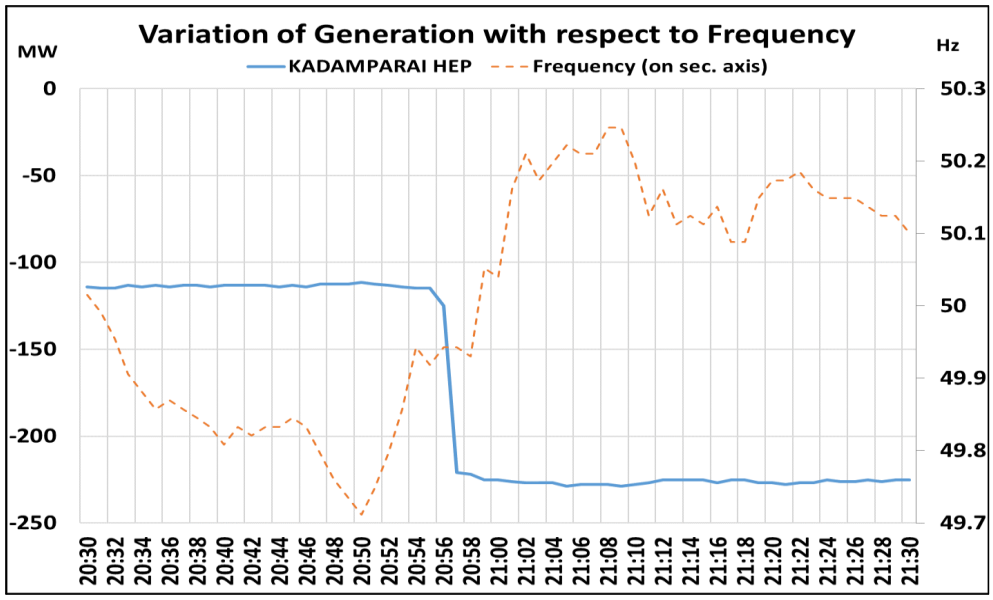


Figure 31: Kadamparai PSP Generation during the event

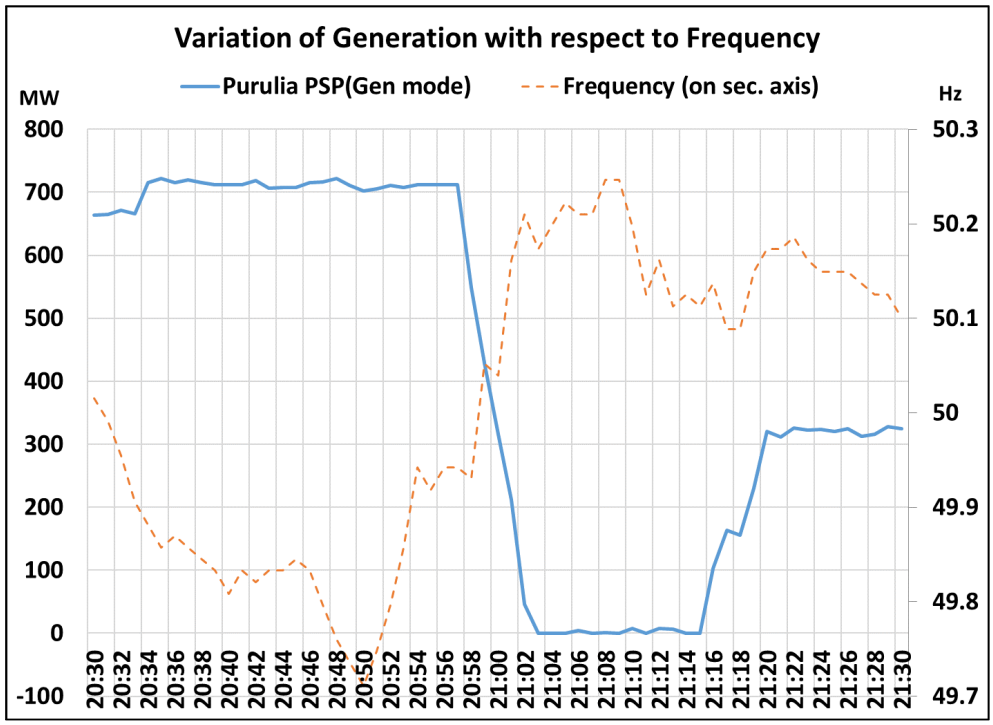


Figure 32: Purulia PSP Generation during the event

Telangana SLDC has reported that relief of 118 MW was received by taking Kaleshwaram Lift Irrigation Pumps in service during the event. The pumps were taken in service at 21:00 hrs to arrest the rise in frequency and were taken out at 21:14 hrs.

9 Cross-border Support from Bhutan Hydro Stations

The possibility of reducing the generation in hydro plants of Bhutan connected to the Indian grid was discussed with Bhutan National Grid Operator before the event. Bhutan National Grid Operator assured their full cooperation during the event and generation flexibility of around 400 MW was achieved during the event with change in generation at Tala, Chukha and Mangdechu HEP of Bhutan. Generation at Tala HEP was reduced slightly early.

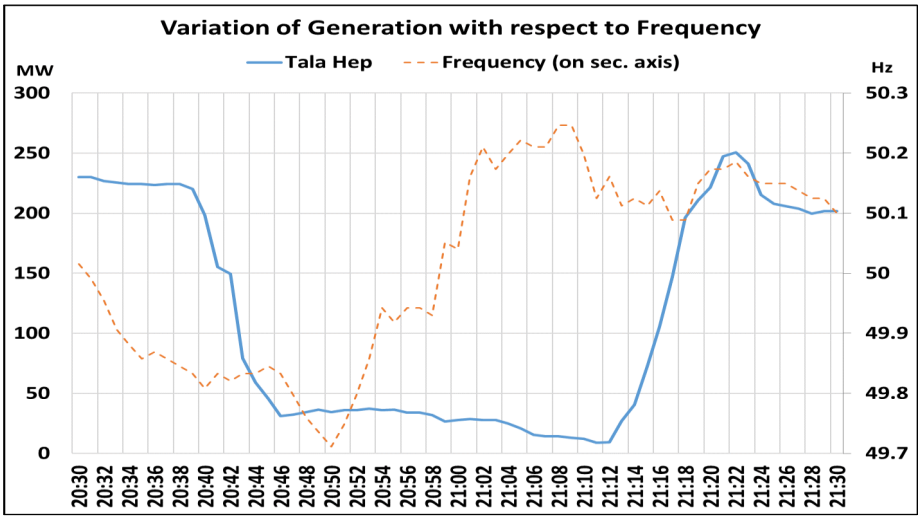


Figure 33: Tala HEP Generation w.r.t. Frequency

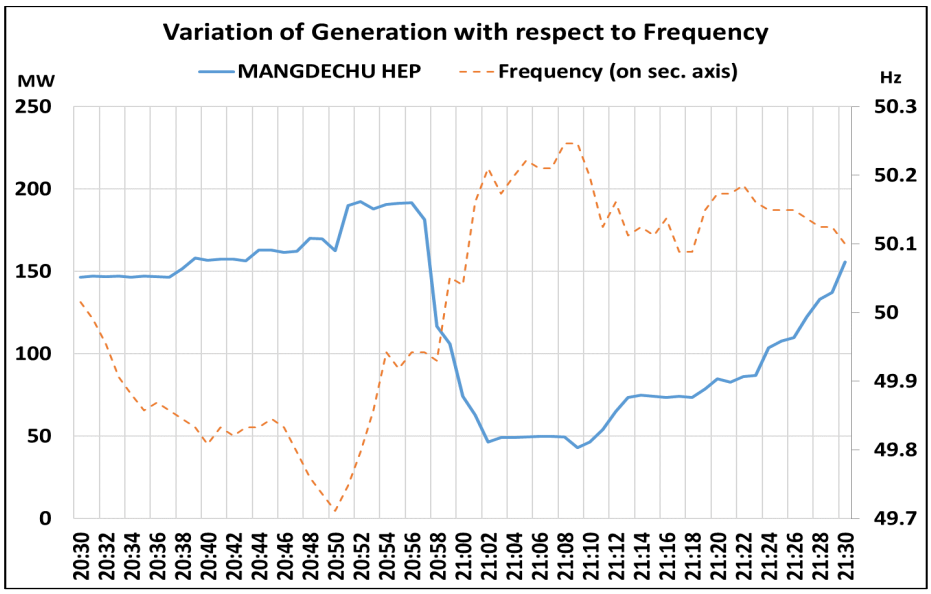


Figure 34: Mangdechu HEP Generation w.r.t. Frequency

10 Frequency Trend

During the lights off event, variations in frequency and voltage in the grid were expected due to sudden reduction and rise in demand. In order to check the rise in frequency and voltage during the fall in demand, the antecedent frequency was maintained on the lower side (at 49.70 Hz) by backing down the generation in coal fired stations which have slow ramping down capability. The fast ramping hydro and gas stations were instructed to ramp down their generation to minimum generation levels matching with the fall in demand. With the sudden fall in demand, frequency rose to maximum of 50.26 Hz after at 21:09 hrs with the rate of rise of frequency reaching as high as 0.05 Hz/second at 21:00 hrs. This rise in frequency between 21:00 hrs to 21:09 hrs was arrested by matching fast reduction in generation in hydro and gas stations. The wind generation was also tripped at 50.20 Hz for getting required generation backing down. Post 21:09 hrs, the anticipated dip in frequency due to revival of the disconnected load was prevented by fast ramp up of hydro and gas generation. Through these actions, the frequency was maintained between 50.10 Hz to 50.26 Hz between 21:00 to 21:30 hrs.

Comparison of the grid frequency as well as rate of change in frequency recorded in Phasor Measurement Units between 20:30 hrs to 21:30 hrs on 04th April and 5th April is shown below.

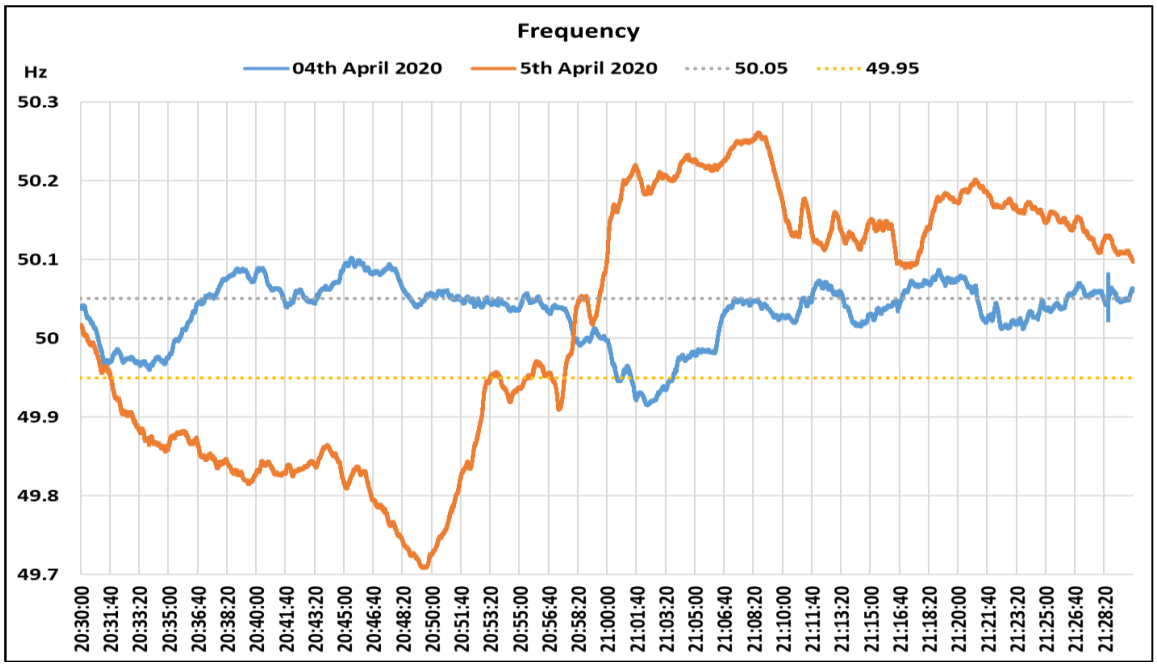


Figure 35: Frequency Profile during the event

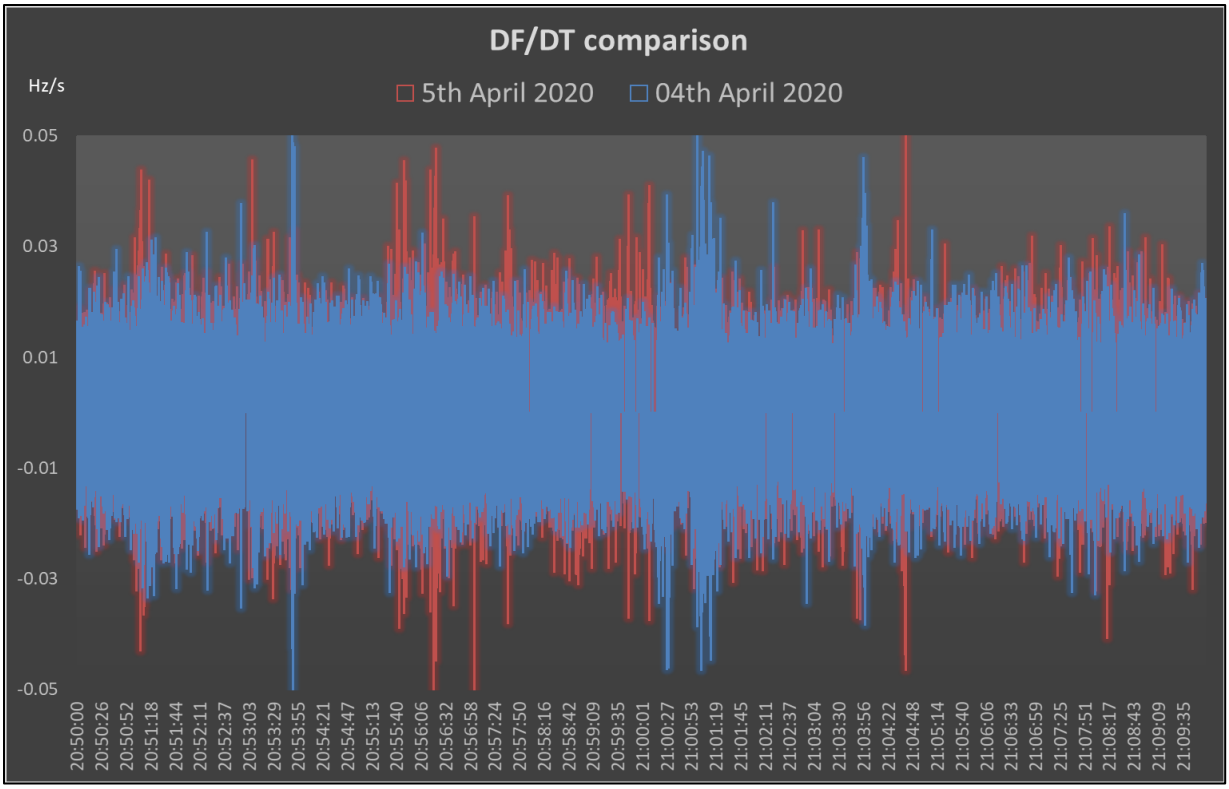


Figure 36: Rate of change of Frequency during the event

The one second data of grid frequency during the event obtained from PMU at Vindhyachal is enclosed at **Annexure – 10.1**.

11 Voltage Management

As mentioned in section 2.4.1, following actions were taken before the event for voltage control.

- Around 200 transmission lines of voltage level 400 kV and above (HVAC and HVDC) were kept open for voltage control.
- Bus and Switchable Line Reactors were taken in service, wherever required.
- SVCs at 400 kV Kankroli, Kanpur, New Wanpoh and Ludhiana S/s were taken in voltage control mode with reference voltage of 400 kV. Instructions were also issued to modify the settings of STATCOMs as per requirement.
- All the generating plants were advised to absorb/generate reactive power as per requirement. Wind turbine generators were advised to operate in voltage control mode instead of constant power factor mode.
- SLDCs/DISCOMs were advised to switch off capacitor banks at distribution level. As gathered from reports submitted by SLDCs, most of the DISCOMs switched off capacitor banks at distribution level before the event.
- Tap position of transformers were optimized to maintain desired voltages.

11.1 Voltage Control

11.3.1 Opening of Transmission Lines

With all India demand already being 30-40 GW less than the usual demand in the month of April due to countrywide lockdown since 25th March 2020, 150-200 lines at 400 kV voltage level and above were already kept open or being opened for voltage control. These measures had successfully helped in keeping the system voltages within the Indian Electricity Grid code (IEGC) band. Further, simulation studies were carried out to identify additional lines which could be opened for voltage control without compromising the reliability. These lines were opened by 20:00 hrs of 5th April in order to keep the voltages within limits before and during the event. The details of number of lines kept out for voltage control since 1st March 2020 are given below. The increase in number of lines being opened after countrywide lockdown from 25th March 2020 is clearly evident from the graph. Usually, maximum number of lines are opened during night hours i.e. the time during which the daily minimum demand is recorded. Therefore, similar actions during the event kept the voltages within permissible limits.

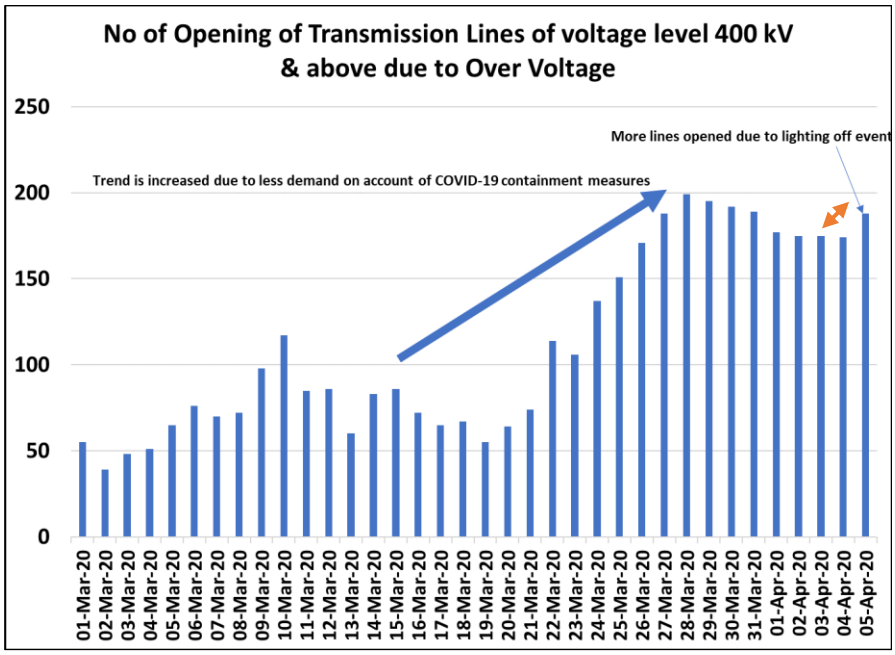
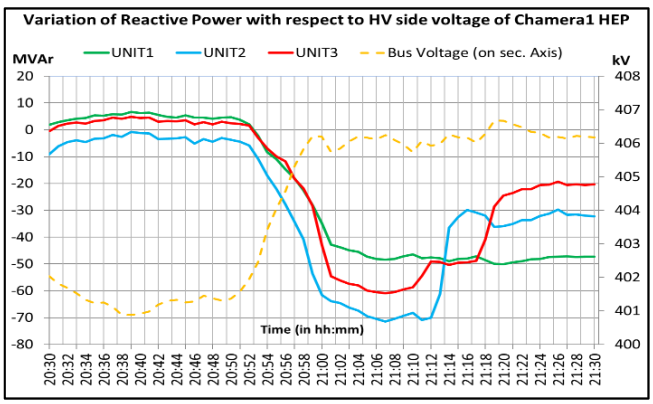


Figure 37: Number of lines opened for voltage control since 1st March 2020

11.3.2 Reactive Power Support by Generating Stations

Prior to the event, all the generating stations were advised to absorb/generate reactive power as per grid requirement (Automatic Voltage Regulator [8]in auto mode). During the event, the rise in voltages was significantly contained by the absorption of reactive power by generators. The trend of reactive power generation/absorption by generators with change in bus voltage during the event is enclosed at **Annexure – 11.1**.



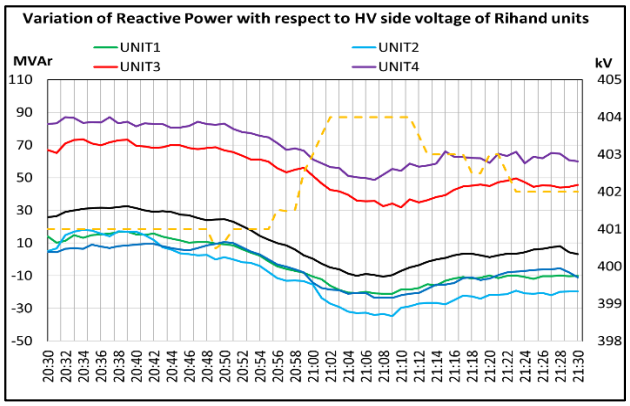


Figure 38: Reactive Power Variation by Chamera -1 HEP and Rihand TPS

[8] *Automatic Voltage Regulator or AVR means a continuously acting automatic excitation control system to control the voltage of a generating unit measured at the generator terminals*

11.3.3 Response of STATCOMs and SVCs

In the detailed advisory issued by POSOCO before the event, it was advised to keep SVCs and STATCOMs in voltage control mode with reference voltage of 400 kV. Further, instructions were also issued to concerned agencies to revise the settings of STATCOMs as per requirement. The change in settings of Gwalior, Satna, Aurangabad and Solapur STATCOMs done prior to the event are as under:-

S.No.	Element Name	Original Settings	Settings Kept on 5-Apr-20
1	MSR-1,2 (125 MVAR)	In : 1.03pu, 5 sec Out : 0.99pu, 5 sec	In : 1.00pu, 5 sec Out : 0.99pu, 5 sec
2	STATCOM-1,2 (±2x100MVAR)	Up set : 1.03pu Dn set : 0.97pu Slope : 2%	Up set : 1.00pu Dn set : 0.97pu Slope : 2%
3	MSC-1 (125 MVAR)	In : 0.97pu, 5 sec Out : 1.01pu, 5 sec	In : 0.97pu, 5 sec Out : 0.99pu, 5 sec

Table 9: Existing and Revised STATCOM settings at Gwalior

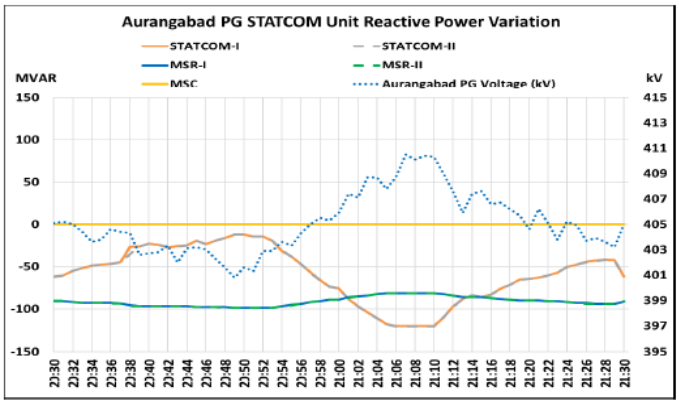
S. No.	Element Name	Original Settings	Settings Kept on 5-Apr-20
1	MSR-1,2 (125 MVAR)	In : 1.03pu, 5 sec Out : 0.99pu, 5 sec	In : 1.00pu, 5 sec Out : 0.99pu, 5 sec
2	STATCOM-1,2 (±2x150MVAR)	Up set : 1.03pu Dn set : 0.97pu Slope : 2%	Up set : 1.00pu Dn set : 0.97pu Slope : 2%
3	MSC-1 (125 MVAR)	In : 0.97pu, 5 sec Out : 1.01pu, 5 sec	In : 0.97pu, 5 sec Out : 0.99pu, 5 sec

Table 10: Existing and Revised STATCOM settings at Satna

S. No.	Element Name	Original Settings	Settings Kept on 5-Apr-20
1	MSR-1,2 (125 MVAR)	In : 1.03pu, 5 sec Out : 0.99pu, 5 sec	In : 1.00pu, 5 sec Out : 0.99pu, 5 sec
2	STATCOM-1,2 (±2x150MVAR)	Up set : 1.03pu Dn set : 0.97pu Slope : 2%	Up set : 1.00pu Dn set : 0.97pu Slope : 2%
3	MSC-1 (125 MVAR)	In : 0.97pu, 5 sec Out : 1.01pu, 5 sec	In : 0.97pu, 5 sec Out : 0.99pu, 5 sec

Table 11: Existing and Revised STATCOM settings at Aurangabad and Solapur

The response of STATCOMs at Aurangabad and Nalagarh and SVCs at Kanpur and Kankroli during the event is given below.



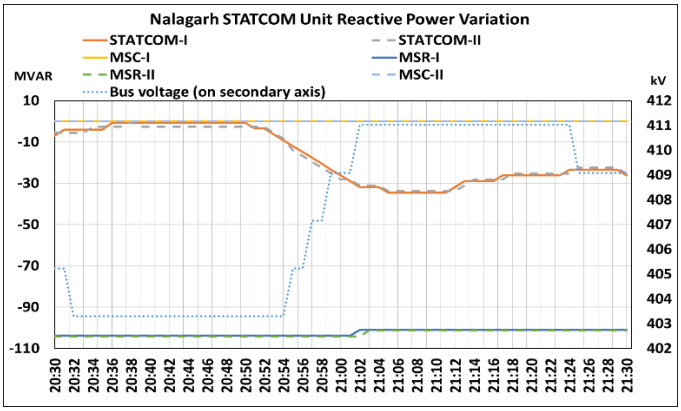
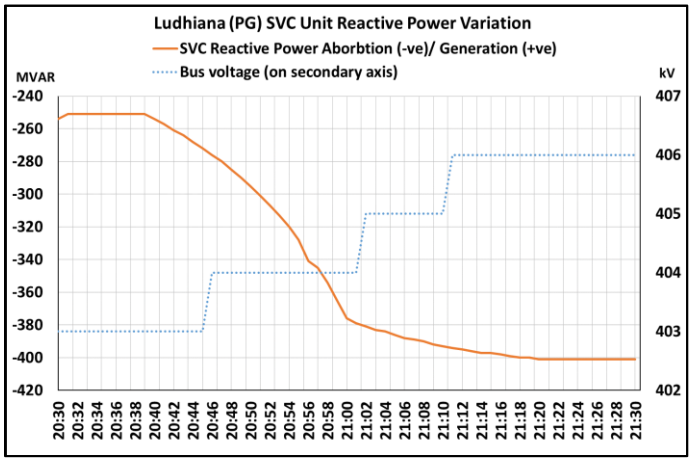
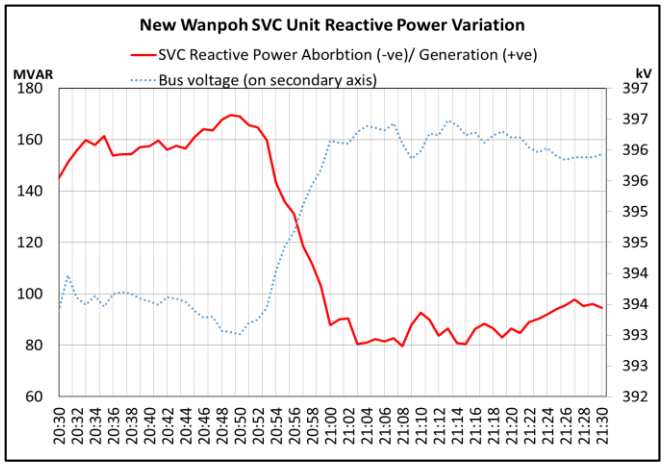
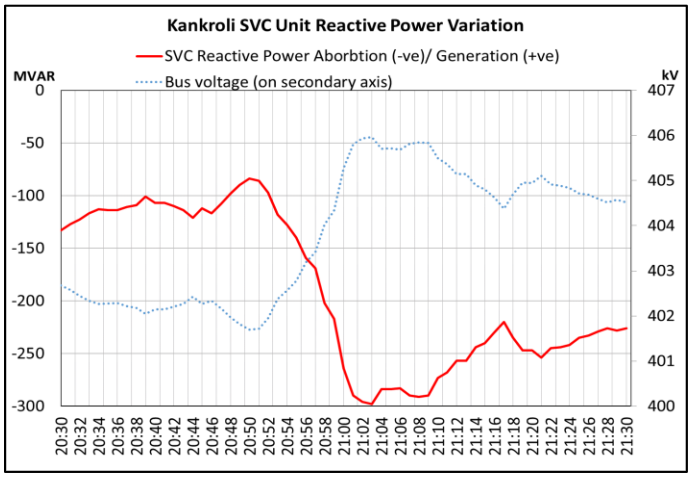


Figure 39: Response of STATCOMs at Aurangabad and Nalagarh







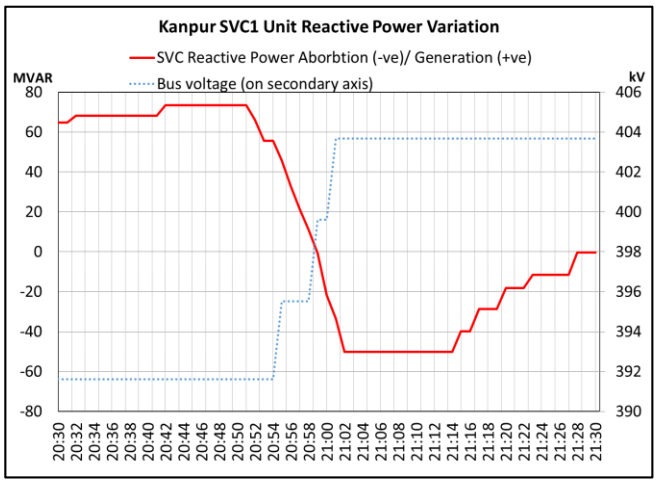


Figure 40: Response of SVCs in Indian Grid

The response of all the STATCOMs in the Indian grid during the event is enclosed at **Annexure-11.2**.

11.2 Voltage Profile during the event

The voltages remained within the permissible range at most of the stations across the country. Among 765 kV stations, the voltage remained within the permissible range for 100% of the time at each stations (except at Fatehpur and Maheshwaram) during the whole event. The maximum and minimum voltage at 765 kV level recorded during the event was 794 kV at Ektuni and 725 kV at Fatehpur respectively. The maximum and minimum voltage at 400 kV level recorded during the event was 434 kV at Kalwa and 387 kV at Arambag respectively.

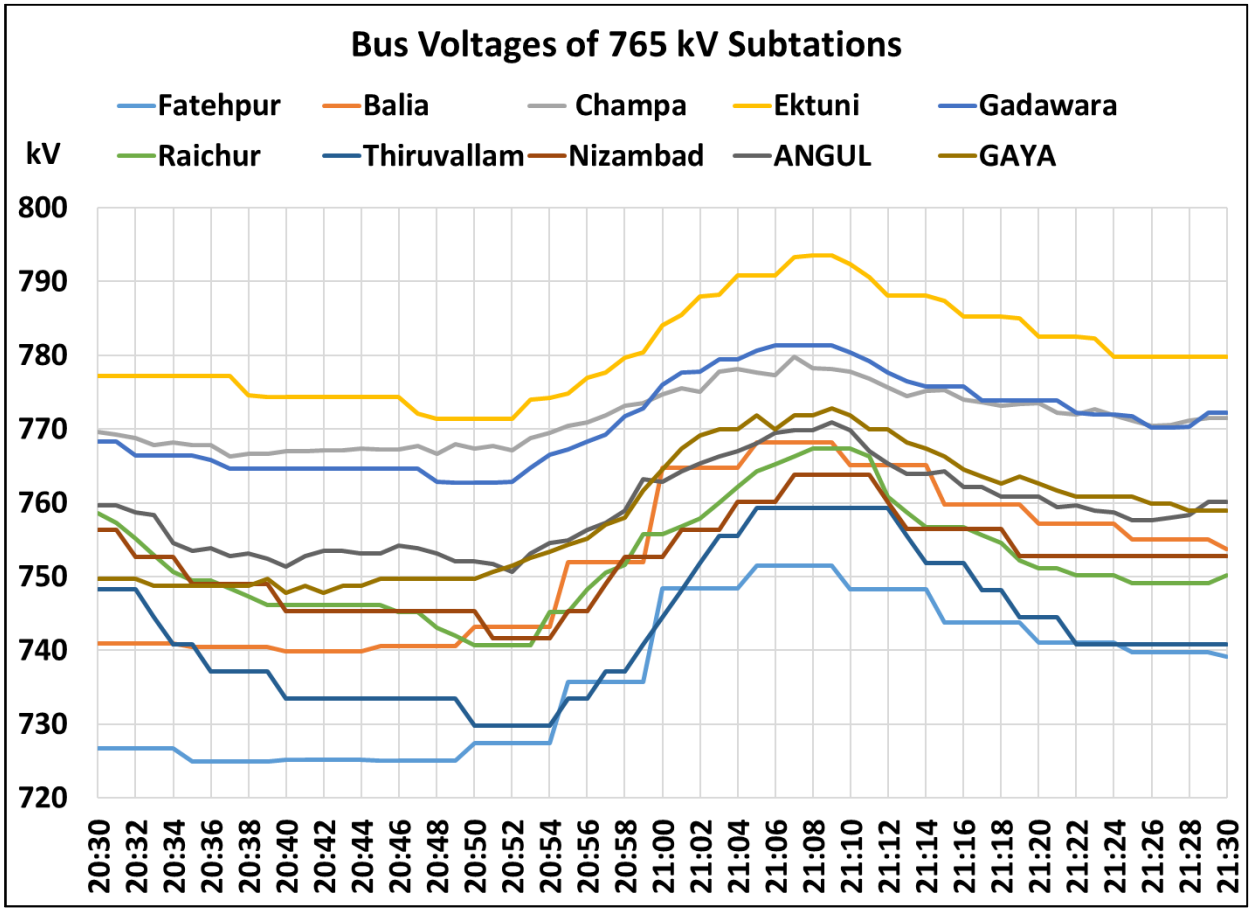


Figure 41: Voltage Profile of different 765 kV Stations across the country

The voltage details at major 765 kV stations during the event are given below.

Voltage Statistics of 765 kV stations during Light Off Event on 05-April-2020

S.No.	Station Name	%age of time Voltage above 800 kV	%age of time Voltage between 728 & 800 kV	%age of time Voltage below 728 kV	Max (kV)	Min (kV)
1	Fatehpur	0	59	41	751	725
2	Balia	0	100	0	768	740
3	Moga	0	100	0	757	730
4	Agra	0	100	0	740	740
5	Bhiwani	0	100	0	767	736
6	Unnao	0	100	0	760	733
7	Lucknow	0	100	0	773	742
8	Meerut	0	100	0	765	731
9	Jhatikara	0	100	0	774	740
10	Barilly	0	100	0	777	744
11	Anta	0	100	0	774	755
12	Phagi	0	100	0	774	751
13	Bina	0	100	0	770	751
14	Gwalior	0	100	0	772	750
15	Seoni	0	100	0	774	755
16	Sipat	0	100	0	770	760
17	Wardha	0	100	0	772	748
18	Bilaspur	0	100	0	770	757
19	Sasan	0	100	0	771	761
20	Satna	0	100	0	776	760
21	Indore	0	100	0	761	743
22	Indore	0	100	0	761	743
23	Kotra	0	100	0	778	765
24	Tamnar	0	100	0	778	766
25	Jabalpur	0	100	0	777	758
26	Durg	0	100	0	776	761
27	Auranagabad	0	100	0	768	746
28	Solapur	0	100	0	778	751
29	Raichur	0	100	0	767	741
30	Tirora	0	100	0	765	755
31	Akola-II	0	100	0	790	770
32	Koradi	0	100	0	772	757
33	Dhule	0	100	0	763	740
34	Bhopal	0	100	0	764	746

Voltage Statistics of 765 kV stations during Light Off Event on 05-April-2020						
S.No.	**Station Name**	**%age of time Voltage above 800 kV**	**%age of time Voltage between 728 & 800 kV**	**%age of time Voltage below 728 kV**	**Max (kV)**	**Min (kV)**
35	Dharamjaygarh	0	100	0	767	754
36	Pune	0	100	0	782	756
37	Vadodara	0	100	0	771	763
38	Vadodara	0	100	0	787	772
39	Champa	0	100	0	780	766
40	Ektuni	0	100	0	794	771
41	Gadawara	0	100	0	781	763
42	Nellore PS	0	100	0	761	737
43	Kurnool	0	100	0	763	736
44	Raichur	0	100	0	767	741
45	Thiruvallam	0	100	0	759	730
46	Nizambad	0	100	0	764	742
47	Srikakulam	0	100	0	772	760
48	Maheshwaram	0	92	8	751	727
49	Angul	0	100	0	771	751
50	Gaya	0	100	0	773	748
51	Jharsuguda	0	100	0	777	763
52	Sasaram	0	100	0	764	739
53	New Ranchi	0	100	0	774	762

Table 12: Voltage Profile of major 765 kV stations during the event

The voltage trend of 765 kV and 400 kV stations during the event is at enclosed at **Annexure-11.3.**

11.3 Voltage Unbalance in system

The analysis for phase wise voltage difference has been carried out for 154 number of substations and it has been observed that there is no deterioration in the unbalance during the event. The details of voltage unbalance at 765 kV and 400 kV stations between 20:30 hrs to 21:30 hrs of 5th April 2020 are given below. During the event, voltage unbalance limit was not violated at any of the substations.

S.No.	Station Name	State	Region	Voltage Unbalance (%)			Voltage Unbalance Limit (%)
				Average	Maximum	Minimum	
1	Gadarwara	Madhya Pradesh	WR	0.61	0.64	0.59	1.50
2	Khandwa	Madhya Pradesh	WR	1.11	1.17	1.04	1.50
3	PADGHE	Maharashtra	WR	0.85	0.92	0.78	1.50
4	SIPAT	Chhattisgarh	WR	0.53	0.54	0.52	1.50
5	VADODARA GIS	Gujarat	WR	0.83	0.87	0.77	1.50
6	Srikakulam	Andhra Pradesh	SR	0.72	0.76	0.69	1.50
7	New Ranchi	Jharkhand	ER	0.35	0.40	0.30	1.50

Table 13: Voltage Unbalance Statistics of 765 kV Stations

The statistics of voltage unbalance at 400 kV stations during the event along with the plots for both 765 kV and 400 kV stations are enclosed at **Annexure-11.4**.

12 Angular Separation

The angular difference between important nodes was continuously monitored in control room for observing any stability related issues. The angular separation between important nodes remained within normal range. This reflects the effective generation management matching with the fall and rise in demand by most of the states and each region in distributed manner across the country. The angular difference between important nodes during the event is given below.

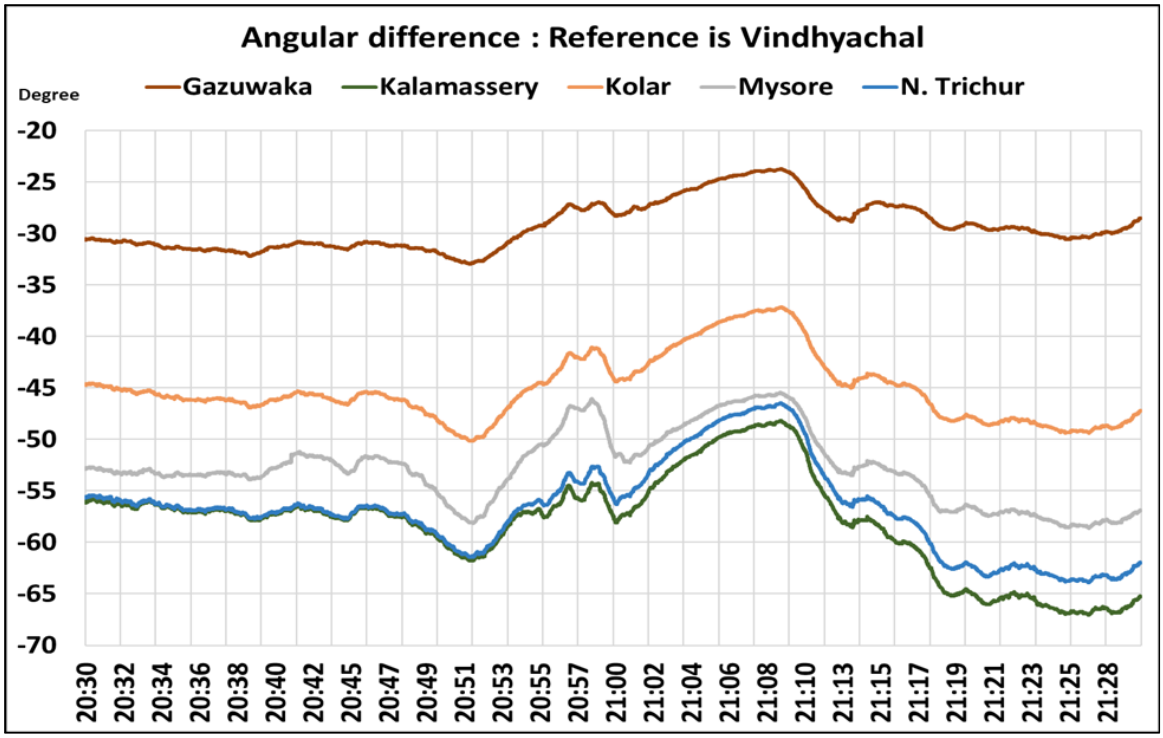


Figure 42: Variation in Angular Separation between important nodes

Further details and plots of variation in angular separation during the event are enclosed at **Annexure-12.1**.

13 Power System Modes

Power system modes were monitored in real time using PMU data. The Oscillation Monitoring System (OSM) tool available at NLDC and RLDCs monitors the modes of frequencies and their damping ratio. In OSM, for inter-area, intra-area and local area oscillation analysis modes having frequencies between 0.2-0.5 Hz, 0.5-1.0 Hz, 1.0-2.0 Hz, 2.0-3.0 Hz and 3.0-4.0 Hz were monitored individually.

In the time window of 20:30 hrs to 21:30 hrs of 05th April 2020, no negative damping was observed in Indian power system. The system was well damped in all the different frequency ranges. Also none of the generators or utilities have reported any oscillatory behavior during ramp up or ramp down period. The trend of damping ratios of modes having frequencies mentioned above are shown below.

S.No	Mode Frequency Range	Mode Damping Ratio Range
1	0.2-0.5 Hz	4.5-12 %
2	0.5-1.0 Hz	0.5-5 %
3	1.0-2.0 Hz	0.2-2.6 %
4	2.0-3.0 Hz	0.19-1.3 %
5	3.0-4.0 Hz	0.1-1.4 %

Table 14: Mode Frequency and Damping Ratio

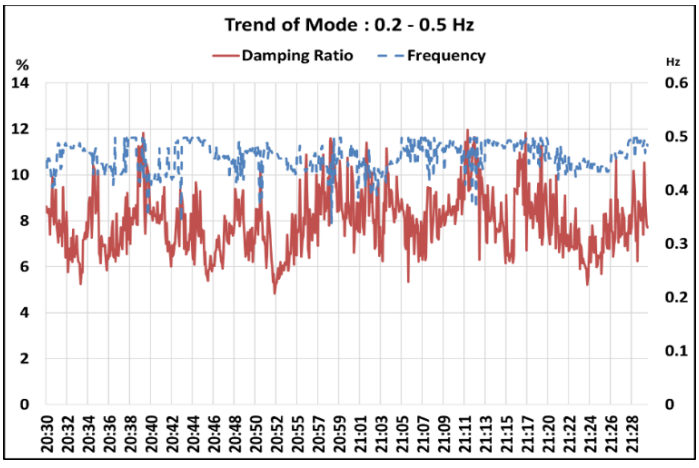
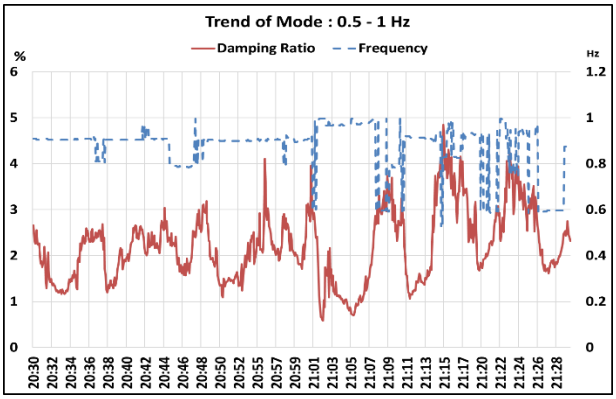


Figure 43: Mode frequency (0.2 -0.5 Hz) with Damping Ratio



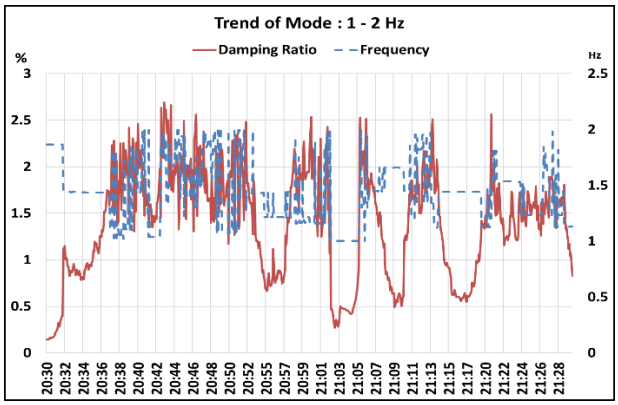
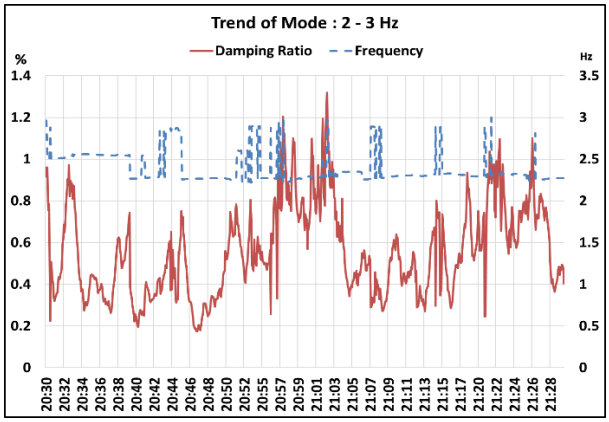


Figure 44: Mode frequency - 0.5 -1 Hz and 1 -2 Hz with Damping Ratio



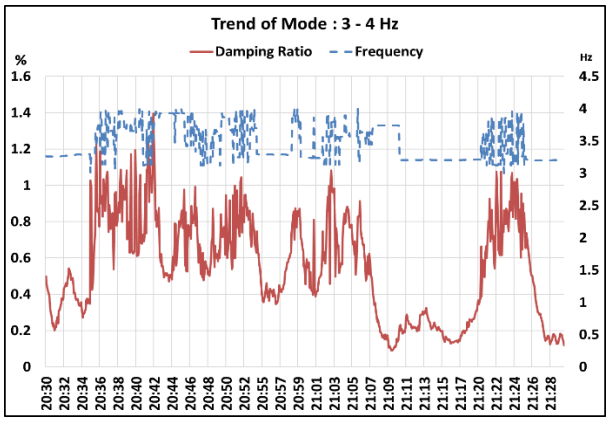


Figure 45: Mode frequency 2 -3 Hz and 3 -4 Hz with Damping Ratio

14 Analysis of the Demand Reduction

The demand reduction anticipated during the lights off event was computed from different methodologies mentioned in section-2.1. From the demand reduction exercise as well as the inputs received from SLDCs, it was anticipated that the total reduction in domestic lighting load on all India level will be in the range of **12-15 GW.** However, the total reduction in all India Demand was to the tune of **31 GW.** Therefore, gap in anticipation and actual, required more detailed analysis. One reason could be that the residents switched off additional loads along with the lighting load. This could be due to general apprehension among the public about equipment damage which was created by the various suggestions floating in social and print media. Another, reason of higher demand reduction could be lighting load actually being higher than the one anticipated. In order to further dwell on these issues, following analysis was carried out.

14.1. Analysis of Load Profile of Urban Clusters

The analysis of load profile of major urban clusters viz., Delhi, DNH and Puducherry (having insignificant agricultural load) shows that, during the event, the demand in these areas went even below the demand at 03:00 hrs, the time at which most of the residential lighting load is usually off and lowest demand of the day is observed. This clearly shows that additional appliances in addition to lighting load might have been switched off during the event.

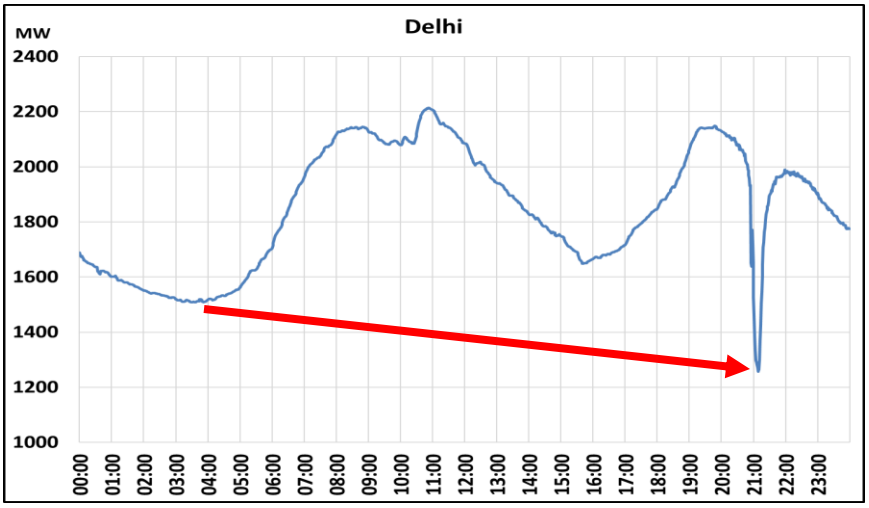


Figure 46: Analysis of Demand Reduction in Delhi

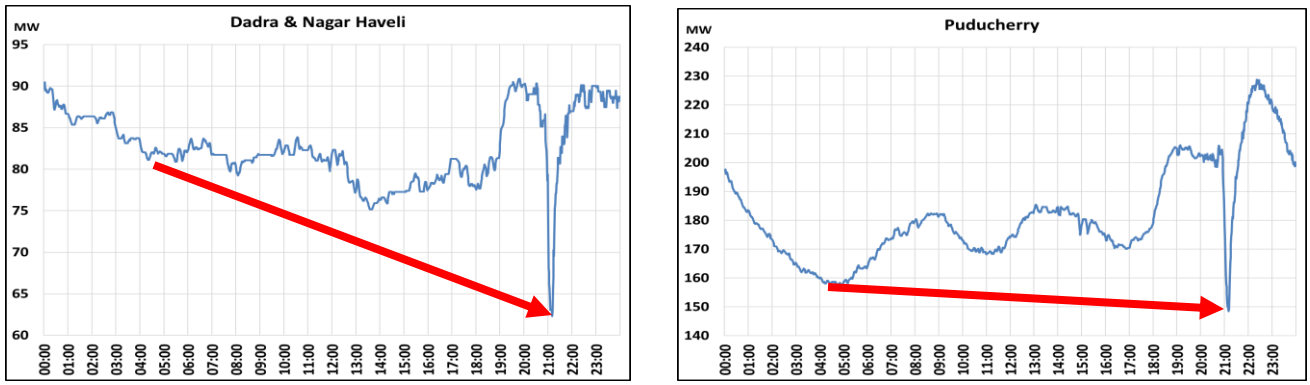


Figure 47: Analysis of Demand Reduction in DNH and Puducherry

In the post-event FOLD meeting held on 9th April 2020, SLDCs were advised to approach respective DISCOMs and analyze the granular smart meter data of either smart city projects or other residential area load. Till the time of writing this report, these details were yet to be received. A sample analysis for the various pockets within the Delhi system was carried out based on the five minute SCADA data available on SLDC Delhi website https://www.delhisldc.org/gridloadcurve.aspx. The same is enclosed at **Annexure -14.1**. It would be observed from the plots at annexure that demand at many of the pockets has gone below the minimum demand usually recorded at 03:00 – 04:00 hrs in the past one week.

14.2. Decline in Television Viewership[9]

The TV viewership data provided by BARC (Broadcast Audience Research Council), India for the #9pm9min event period shows a drop of nearly 60% in all India TV viewership on 5th April 2020 starting from 20:40 hrs to 21:11 hrs. The plot below shows the viewership pattern for 4th, 5th and 6th April 2020. It can be observed that on 5th April, the viewership started dropping from 250 million at 20:40 hrs to 100 million at 21:11 hrs. The viewership started normalizing after 21:11 hrs and achieved usual trend by 21:41 hrs.

A brief description of the methodology used by BARC for arriving at the viewership estimates is available at https://www.barcindia.co.in/Description-Of-Methodology.aspx.

[9] *Data and Information Courtesy for this section: Broadcast Audience Research Council, India*

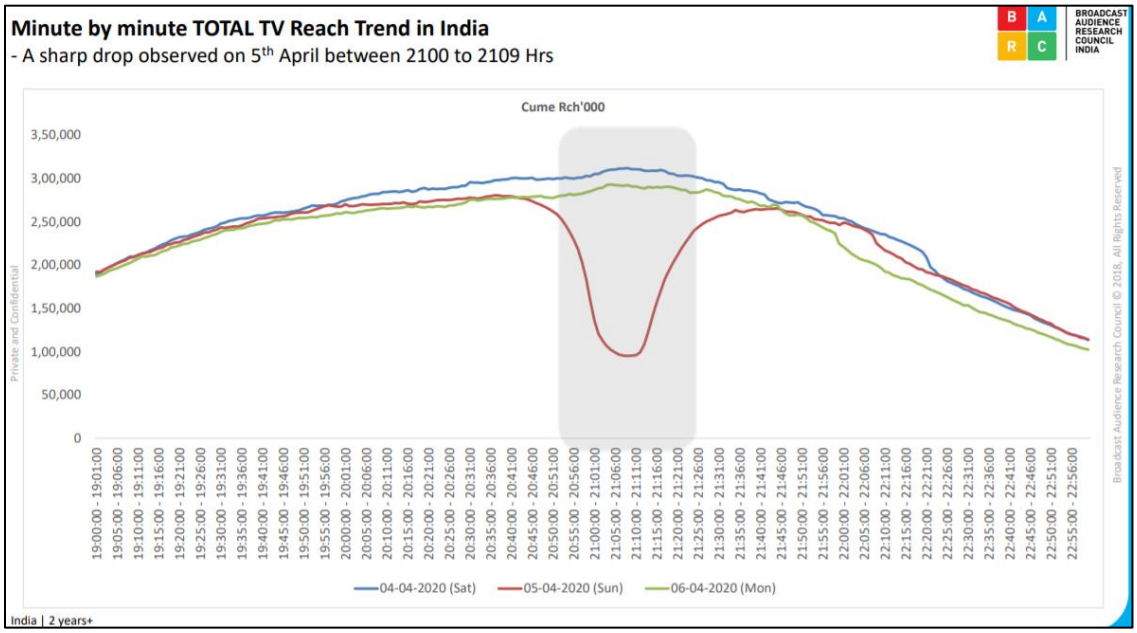


Figure 48: Pan India TV Viewership during #9pm9min lights off event

The viewership trend for rural India was different from urban India since the rural viewership started declining at 20:26 hrs i.e. approximately 15 minutes before urban India and achieved usual trend at 21:51 hrs i.e. approximately 10 minutes later compared to urban India. The viewership trends for urban and rural India are given below.

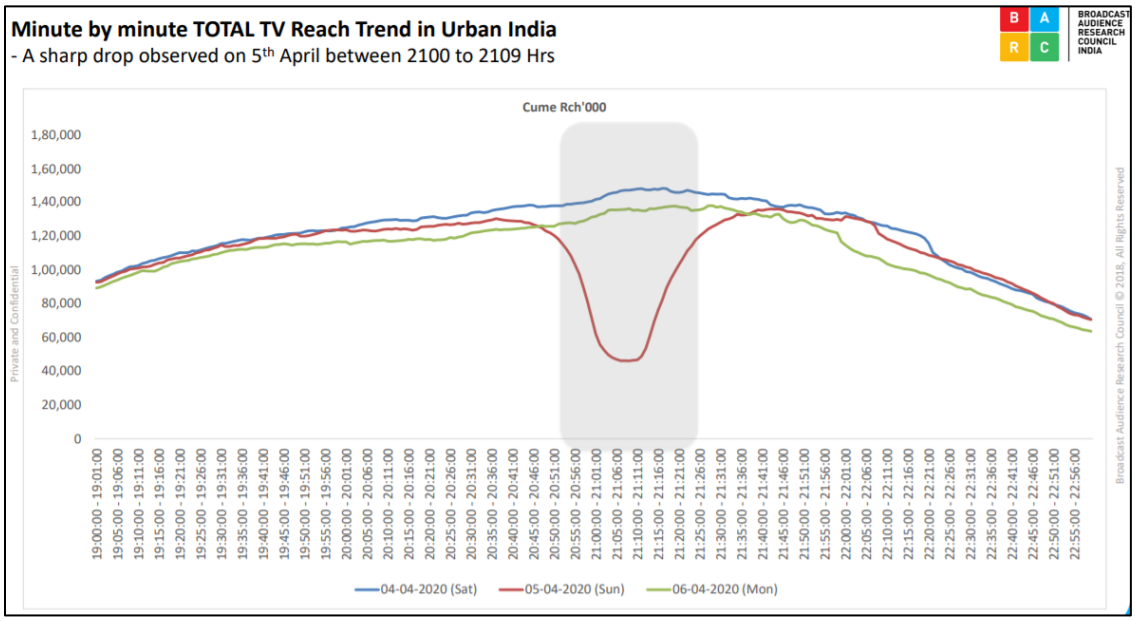


Figure 49: Urban India TV Viewership during #9pm9min lights off event

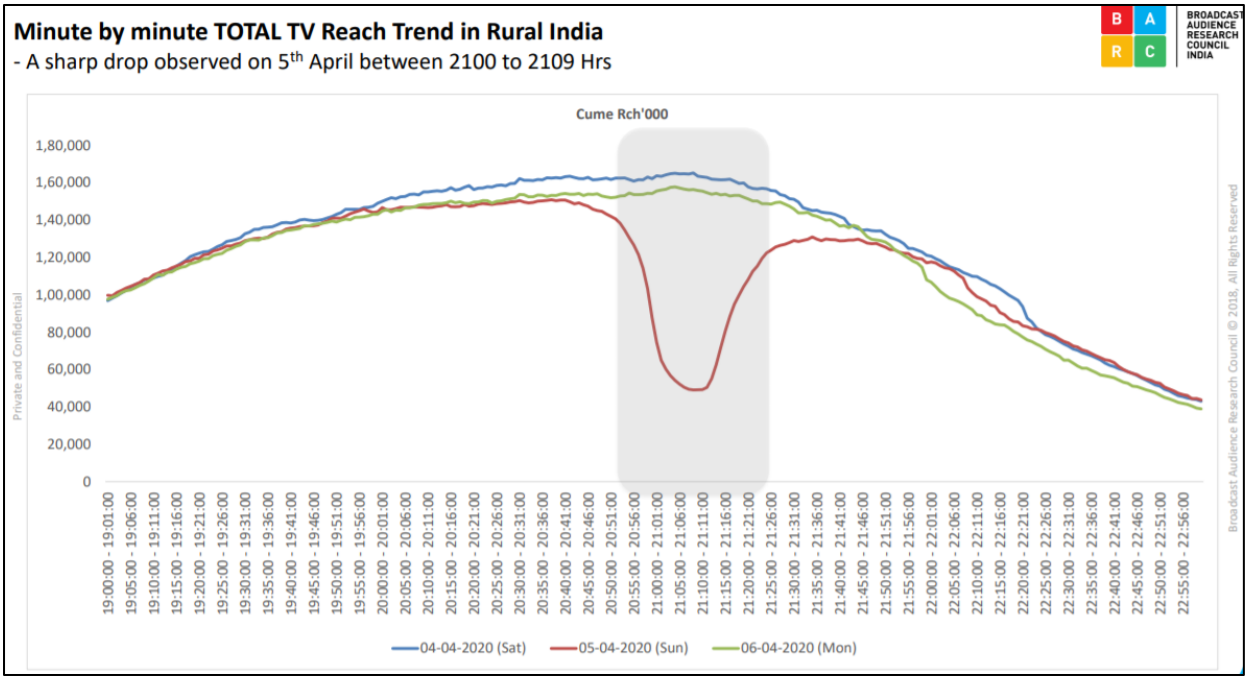


Figure 50: TV Viewership during #9pm9min lights off event-Rural India

As per the latest BARC India universe estimate - 2018, the total TV owning households in India are 197 million out of which around 3% are multi TV owning households. Therefore, the total TV sets in India are estimated to be around 203 million. As per the estimate, there are around 835.8 million individuals having access to TV viewership. Therefore, per TV viewership in the country comes out to be 4.25 (835.8/197). The decline of 150 million in viewership during the above period suggests that approximately 35 million TV sets were switched off. Considering average power consumption of 100 W per TV, the drop in demand due to switching off TV sets alone comes out to be 3.5 GW.

Apart from the above, the trend of television switch off data also very well correlates to the demand drop as well as demand pickup post event. This indicates the reason for early drop in demand (started dropping by 2045 hrs instead of 2100 hrs) and later for delayed pickup of the same.

From this report also, it is evident that citizens disconnected additional household load apart from the residential light load.

14.3. Analysis of Load Profile of Individual Households

An analysis of the minute-wise load and voltage data of 210 households (among various cities) of 5th April 2020 has also been carried out by PRAYAS (Energy Group) to understand the response of households during the lights-off event. In the analysis, there is a mention of percentage of households who had zero load during the event.

The key takeaways of the analysis are as under:-

a) About 80% of the households in the sample responded to the call by switching off some of their load during the event time.

b) Average demand reduction of 204 W/household of the sample was observed whereas the recovery was about 152 W/household.

c) About 55% of the households in the sample followed the timings closely

d) About 13% of the households had zero load during the event, some due to switching off all appliances and some due to power-cut.

The detailed analysis may be accessed from the link below.

https://prayaspune.org/peg/blogs/insights-from-emarc-on-response-to-lights-off-event-of-5th-april-2020.html.

The 204 Watt average demand reduction per household is way above the 50 Watt rural and 100 Watt of average demand reduction anticipated in the advisory dated 4th April 2020 issued by NLDC. The basis for NLDC's anticipated demand reduction per household was considering the widespread usage of LEDs looking over the last few years on account of various flagship programs of the Government of India such as UJALA. As per the UJALA dashboard http://www.ujala.gov.in/, approximately 362 million LEDs have been distributed as on 4th May 2020, thereby avoiding a peak load of 9.4 GW (26 Watts saving per LED).

A study on the impact of UJALA program has been done by PRAYAS in August 2017. The report is available at http://www.prayaspune.org/peg/publications/item/354.html.

The following table from Electric Lamp and Component Manufacturers Association (ELCOMA), India suggests significant sale and usage of GLS (General Lighting Service) lamps

and FTL (Fluorescent Tube light) notwithstanding the rapid increase in sale of LED lamps. The power consumption of GLS and FTLs is much higher than LEDs. The 50 Watt and 100 Watt load reduction estimation for rural and urban household respectively would undergo a change based on the actual usage of GLS, FTLs and LEDs across the country.

S.No.	Category	Category-wise Quantity in Milion Pieces per year																
		2010	2011	Gr %	2012	Gr%	2013	Gr%	2014	Gr%	2015	Gr%	2016	Gr%	2017	Gr %	2018	Gr %
A	**Conventional Lighting**																	
1	Lamps -GLS	797	757	-5%	758	0%	780	3%	904	16%	855	-5%	812	-5%	771	-5%	617	-20%
2	FTL	182	194	7%	200	3%	234	17%	257	10%	245	-5%	225	-8%	169	-25%	132	-22%
3	CFL	304	340	12%	401	18%	453	13%	448	-1%	381	-15%	205	-46%	102	-50%	28	-73%
	Total Conventional Lighting (Value Rs. Crore)	7950	9290	17%	10469	13%	11679	12%	12931	11%	13119	1%	9557	-27%	5,939	-38%	3,000	-49%
B	**LED Lighting**																	
1	LED Retrofit Lamps								4.86		62	1176%	251	305%	336	34%	520	55%
2	TLED												56		86	54%	141	64%
3	LED Street Lights								0.23		0.72	213%	1.4	94%	3.2	129%	8.2	157%
	Total LED'S (Value Rs. Crore)	500	850	70%	1250	47%	1825	46%	3395	86%	5092	50%	10449	105%	8,184	-22%	12,000	47%
	Total Lighting (A)+(B)	8450	10140	20%	11719	16%	13504	15%	16326	21%	18211	12%	20006	10%	14,123 *	-29%	15,000 *	6%

*(*The data does not include unorganized sector in 2017 & 2018, which is estimated to be more than 36%)*

Table 15: Sale of various light fittings over the years

(Source: http://elcomaindia.com/wp-content/uploads/Lighting-Data-2018-01.05.2019.pdf)

From the analysis at section 14.1 to 14.3 above, it is therefore evident that much more than lighting load was switched off during the event. This is also clear from the fact that the minimum all India demand recorded during the event i.e. 85799 MW at 21:10 hrs on was even lower than the normal minimum demand of 107236 MW recorded at 03:22 hrs on the same day (the time at which most of the residential lighting load and television sets are usually off). Further, the 85799 MW demand is the lowest all India demand recorded since 2nd March 2015. The GLS and FTLs versus LED usage across the country and its impact on lighting load needs to be studied further.

15 Key Learnings

The #9pm9min event provided various insights into the Indian power system and validated the importance of various controls for a power system operator. The power system is expected to ride through several events of varying severity on a regular basis. Every grid event leaves a lesson which provides both the confidence and experience which is handy for future and this event was no exception. The key learnings from the event are enumerated below.

The following strengths in the system helped in smooth handling of the event: -

- Availability of flexible generating resources in the form of hydro, gas and pumped storage plants. This enabled handling of sharp variations in demand during the event. The flexibility provided by coal fired plants was also significant in matching the fall and rise in demand.

- Availability of a robust pan India transmission network with flexible resources in the form of HVDCs, FACTS devices such as SVCs and STATCOMs. These ensured a congestion free system and availability of reactive power control devices for voltage control. This enabled operation of the entire grid as a single control area solely for the purpose of frequency control.

- Availability of a strong regulatory framework in the form of Indian Electricity Grid Code (IEGC) and other regulations ensuring a robust scheduling, metering, accounting and settlement mechanism.

- Availability of an effective institutional framework for system operation in the form of NLDC, RLDCs and SLDCs which helped in planning and coordination amongst multiple stakeholders in power generation, transmission and distribution.

- Availability of tools for real-time monitoring, visualization and situational awareness at NLDC, RLDCs and SLDCs through SCADA, EMS and synchrophasor technology.

- Availability of communication infrastructure between control centers as well as with the generating stations and transmission licensees.

- Effective knowledge management covering all areas of system operation with particular reference to mock black start drills, hydro and gas flexibility understood through these mock drills. Pilot project on Fast Response Ancillary Services (FRAS) and studies on hydro flexibility[10] done through Forum of Load Despatchers helped in better understanding hydro flexibility.

It is important that the above strengths are further enhanced and improvements may be made in the following areas to handle the electricity grid of the future.

- Better forecasting of demand in different time horizons. This covers the short term (intraday to week ahead), medium term (1 month to 3 years) and long term (beyond 3 years) demand forecast. COVID-19 would influence the demand patterns in each of these time horizons considering the impact of the pandemic on different sectors of the economy.

- Apart from demand forecasts, a good understanding of the time series and spatial demand composition amongst various sectors such as domestic, commercial, agriculture and industry is essential for better operational planning under exceptional situations such as the COVID-19 pandemic, natural disasters and lights out event. Institutional mechanisms such as Distribution System Operators (DSOs) would help in strengthening this aspect.

- Along with the accuracy of demand forecasts, the accuracy of wind and solar generation forecasts is also of utmost importance for proper resource scheduling. This is required both at the NLDC/RLDC/SLDC (for RE connected at transmission level) as well as at the DSO level considering the anticipated increase in grid connected rooftop solar PV in near future.

- Generally, the power system is planned to cater to a N-1 contingency where the contingency is for a typical transmission element. However, the contingency could also be the loss of a control center in case of incidents such as the COVID-19 pandemic

[10] *A detailed report on hydro flexibility was brought out by FOLD in June 2017 is available at* https://posoco.in/hydro-committee-report/

which are low probability high impact events. Therefore, the concept of main and hot standby control centers needs a careful redesign to have better reliability and resilience in the entire system. Such redesign should capture simultaneous occurrence of more than one event; for instance pandemic accompanied by a natural disaster such as cyclone or earthquake, heightened probability of cyber-attack in the work from home environment during the pandemic etc. This redesign philosophy may be extended to all facets of power system planning and operation.

- With peakier daily demand curves and large scale penetration of renewable generation, the requirement of flexible generation would only increase. The flexibility in all the resources such as hydro, gas, storage devices and coal need to be harnessed. Thus, there is a need to recognize the flexibility attribute, provide for measurement of flexibility and incentivize the same through suitable policy & regulatory initiatives.

- Though the anticipated demand reduction during the event was of the order of 12-15 GW, the actual reduction was to the tune of 31 GW. The situation could still be handled successfully due to deployment of a large amount of reserves considering the uncertainties in forecasts. The uncertainties in forecasts both on generation and demand side are bound to increase in future necessitating maintaining of adequate primary response and spinning reserves (secondary and tertiary) in the system during the normal grid operation. Suitable provision for the same in IEGC would help in integration of renewable energy resources besides addressing other uncertainties. Secondary control through Automatic General Control (AGC) needs to be implemented.

- As the penetration of renewable energy increases, the availability of synchronous machines in the system would reduce, leading to less inertia and sharp changes in grid frequency in case of any contingency. The synchronous condenser capability of hydro machines needs to be harnessed in such situations as it would provide threefold benefits viz. inertia, reactive power control and contribution to short circuit level. Thus, there is a need for Reactive Power Ancillary Services to harness the synchronous condenser capability of hydro generators.

- The synchronous condenser facility may also be considered as part of the transmission planning considering the advantages outlined above. The facility could either be

greenfield or brownfield (conversion of old or retired coal/gas fired units to synchronous condensers).

- The event also brings out the potential for having demand response ancillary services in India. The possibility of implementation of same at DSO or SLDC/RLDC level needs to be explored further.

- Continuous capacity building of all stakeholders in the system is required on a regular basis to ensure a shared vision. This should cover upcoming technologies and areas such as Machine Learning, Artificial Intelligence and Big Data Analytics for better decision making under increasing uncertainties in a VUCA [11]world.

- The event also highlights how the social media can affect the consumer behavior and the need to harness it power for positive outcomes.

[11] *VUCA stands for Volatility, Uncertainty, Complexity and Ambiguity*

Annexure 2.1 Advisory, Press Release and FAQs by Ministry of Power, Government of India

Advisory by Secretary to Government of India, Ministry of Power

Government of India/Bharat Sarkar
Ministry of Power/Vidyut Mantralaya
Shram Shakti Bhawan, Rafi Marg, New Delhi
****

Dated, the 4th April, 2020.

Dear Principal Secretary/Secretary (Power)

This is with reference to the appeal of the Hon. Prime Minister to the people to voluntarily switch off their lights at 9.00 PM on the 5th April, 2020. The National Load Despatch Centre has worked out the procedures for grid balancing during the period which they will be communicating to the Regional and State Load Despatch Centres separately. It is requested that the following may be brought to the notice of all concerned.

The appeal of the Honourable Prime Minister to the people is to voluntarily switch off only the lights at 9.00 PM on the 5th April, 2020. There is no call to switch off either streetlights or appliances like TVs, Refrigerators and ACs in homes. Adequate arrangements and protocols are in place to handle the variation in demand. People should be assured not to worry and continue running all the appliances as usual.

Local bodies may be advised to keep the street lights on so as to avoid any law and order problems.

The lights in hospitals and other essential services will remain on.

Detailed instructions are being issued by POSOCO.

Yours sincerely,

(Sanjiv Nandan Sahai)
Secretary to the Govt. of India
Ministry of Power
New Delhi.

To
All Principal Secretaries/Secretaries (Power)

Press Release by Ministry of Power, Government of India

Ministry of Power

Adequate arrangements and protocols are in place to handle grid stability during lights out event on 5th April at 9:00 PM

Posted On: 04 APR 2020 3:56PM by PIB Delhi

The Prime Minister has appealed to the people to voluntarily switch off their lights between 9:00 p.m to 9:09 pm on the 5th of April. Union Ministry of Power in a statement here today has said that some apprehensions have been expressed that this may cause instability in the grid and fluctuation in voltage which may harm the electrical appliances. Dispelling these apprehensions, Ministry of Power has said that they are misplaced.

The Ministry has emphasised that Indian electricity grid is robust and stable and adequate arrangements and protocols are in place to handle the variation in demand.

The Power Ministry further said that following may be noted:

The appeal of the Prime Minister is to simply switch off the lights in their homes from 9 pm to 9:09 pm on the 5th of April. There is no call to switch off either street lights or appliances like Computers, TVs, Fans, Refrigerators and ACs in the homes. Only lights should be switched off. The lights in Hospitals and all other essential services like Public Utilities, Municipal Services, Offices, Police Stations, Manufacturing Facilities, etc will remain on. The call given by PM is to just switch off lights in residences.

All local bodies have been advised to keep the street lights on for public safety.

RCJ/M

(Release ID: 1611020)

FAQs by Ministry of Power, Government of India

Press Information Bureau
Government of India
Ministry of Power
05-April-2020 17:21 IST

FAQs on Power Grid operations during light out

Allays all doubts about grid instability

Question 1: Are only domestic lights to be switched off or are street lights, common area lighting, essential services etc lights also to be switched off between 9 - 9:09 pm?

Answer: Only domestic home lights in the houses have to be put off voluntarily as appealed by our Hon'ble PM. It is again reiterated that no street lights, common area places, hospitals and other essential services have to switch off their lights.

Question 2: Are my domestic appliances safe during the said switching off of home lights ?

Answer: All your domestic appliances will be safe. There is no need to switch off Fans, ACs, Fridges etc. Indian Electricity Grid is well designed to handle such kind of load variation and has several in- built levels of control and safety mechanisms to absorb any kind of frequency changes occurring due to such load variation. Thus, all the domestic appliances will be totally safe and hence should be kept in normal functioning mode as per the requirements.

Question 3 : Whetheradequate arrangements and protocols are in place to handle grid stability during light out event on 5th April at 9:00 PM to 9.09pm ?

Answer : Yes, all adequate arrangements and standard operating protocols are in place to maintain grid stability.

Question 4: Is it compulsory or voluntary to switch off lights?

Answer : Voluntary . As already said only domestic home lights have to be put off .

Question 5: Some apprehensions have been expressed that this may cause instability in the grid and fluctuation in voltage which may harm the electrical appliances.

Answer : These apprehensions are totally misplaced. These are normal phenomenon and the Indian Electricity Grid is well designed to handle such load variation and frequency changes as per standard operating protocols.

Question 6 : Whether our grid management and technology deployed will withstand the fluctuation that light out may cause ?

Answer : Indian electricity grid is robust and stable and employs state-of -art technology. It has in place necessary control and protective elements capable of handling such kind of fluctuations in demand at any instant of time.

Question 7 : Whether appliances like fan, Refrigerators , AC, etc should be switched off or kept in the on mode?

Answer : All your domestic appliances would be safe. These appliances should be operated normally as per requirements by the consumers. No need at all to especially switch off at 9pm.

Question 8 : Whether Street Lights will go off.

Answer : No.

Infact, all States/UTs/ Local bodies have been advised to keep the street lights on for public safety.

Questions 9: Whether Hospitals or other emergency and important installations will face light out.

Answer : No, the lights in Hospitals and all other essential services like Public Utilities, Municipal Services, Offices, Police Stations, Manufacturing Facilities, etc will remain on. The call given by Hon'ble PM is to just switch off lights in residences.

Question 10: The load of home-lightings alone is around 20% of the total load. Would a sudden disconnect of 20% load not destabilise the grid? What measures will the Ministry take?

Answer : Domestic lighting load is much less than 20 per cent. Such kind of reduction in demand can be easily managed for which standard technical operating protocols are in place.

Question 11: Will there be load shedding ? If yes what will be the impact ?

Answer : No load shedding is planned.

***

RCJ/M

Annexure 2.2 Operational Guidelines Issued by POSOCO

Power System Operation Corporation Limited

National Load Despatch Center

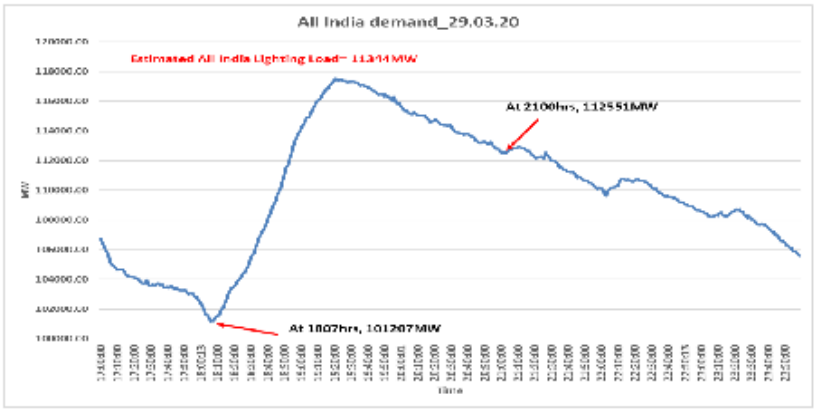
Ref. No.: NLDC/SO/2020-21 **Date: 04th April 2020.**

Sub: Advisory for Reliable & Secure System Operation during the lighting load switch off on 05th April 2020 at 21:00 hrs for nine (9) minutes.

In order to ensure reliable and secure grid operation during upcoming event, a meeting of all SLDCs, RLDCs and NLDC was convened on 4th April 2020. The operational guidelines finalized after discussion are outlined below:-

A.) Estimate of demand reduction:

From the demand pattern of 29th March 2020 (Sunday), it has been observed that nadir All India demand was around 101207 MW at 1807 hrs and subsequently it has increased up to 112551 MW at 2100 hrs during evening peak. Therefore, considering the load behavior, it is anticipated that lighting load of household consumers may be the difference of all India demand at 18:07 hrs and 21:00 hrs i.e. 11344 MW. The all India demand curve of 29th March 2020 is given below.



Further, a separate exercise has been carried out to find the total demand reduction at grid level based on the number of household consumers in India. The calculated total reduction in demand which is reflected at grid level is 12452 MW. The summation of demand reduction anticipated by SLDCs for respective states is approx. 15085 MW. The complete state wise load reduction details are attached as Annexure-I and summary of region wise load reduction details is tabulated below.

Region Wise Details of load reduction during light switch off event on 05th April 2020									
S.No.	Region	No of Rural household consumers (a)	No of urban household consumers (b)	Load of Rural household consumers (MW) (c = 50*a)	Load of urban household consumers (MW) (d = 100*b)	Reduced Load of Rural household Consumers (MW) (e = c*.80)	Reduced Load of urban household Consumers (MW) (f = d*.80)	Total Reduced Demand as reflected at consumer level (MW) (g = e+f)	Total Reduced Demand as reflected at Grid level (MW) (g / 0.9)
1	Northern	42293470	13214064	2115	1321	1692	1057	2749	3054
2	Western	35669904	19020928	1783	1902	1427	1522	2948	3286
3	Southern	43854642	4668665	2193	467	1754	373	2128	3407
4	Eastern	41183918	4515705	2059	452	1647	361	2009	2168
5	North Eastern	8362568	1689177	418	169	335	135	470	537
	Total	171364502	43108539	8568	4311	6855	3449	10303	12452

From both the above methods and as per inputs received from SLDCs, it is inferred that total reduction in domestic lighting load on all India level is anticipated in the range of 12-14 GW.

Unlike normal operation, this reduction in load of the order of 12-14 GW would happen in 2-4 minutes and will recover nine minutes later within 2-4 minutes. This sharp reduction in load and subsequent recovery, which is unprecedented, will need to be handled through hydro and gas resources identified and enclosed at Annexure-II.

B.) Generation Scheduling & Frequency Control

a. All clocks at generating stations may be synchronized to Indian standard time (IST).
b. During the evening peak hours i.e. from 18:10 to 20:00 hrs, hydro generation will be reduced and conserved for providing flexibility during 21:00 hrs event. During this time thermal and gas generation shall be scheduled in a manner so as to manage the peak.
c. Subsequently after the peak hours, thermal Inter State Generating Stations (ISGS) generation would be gradually reduced to near technical minimum level of 60 % by 20:55 hrs. and simultaneously hydro generation shall be increased to maintain the load generation balance.
d. Hydro generation and gas generation shall be ramped down starting from 20:57 hrs. keeping a watch on the system frequency. The hydro units should be kept rolling at 0 – 10 % of the rating and not to be disconnected during this period. Gas station shall be ramped down to the minimum level.
e. Ramping up of thermal machines shall be carried out from 21:05 hrs onwards. Further, from 21:09 hrs onwards, Hydro generation shall be ramped up to meet the increase in load. After stabilization of system parameters, hydro units may be withdrawn in consultation with RLDCs & SLDCs.
f. Pumped storage hydro units shall be brought in pumping mode by 20:45 hrs and will be kept in service till 21:09 hrs. After that, machines shall be withdrawn

from the grid through under frequency relays graded between 49.90 to 49.70 Hz amongst the units at each of the pumped hydro stations.

g. Wind generators of ISGS/ intra state level shall be advised to automatically disconnect the wind generating plants at the ISTS/intra state transmission level when frequency is more than 50.2 Hz. This over frequency setting may be removed after the event & units synchronized after 21:30 hrs. This setting may be implemented at the transmission level sub-stations.
h. For having a better level of ramping resources, Security Constrained Economic Despatch (SCED) may be stopped from 1800 hours onwards and would be resumed any time after the event.
i. All India grid frequency may be kept at lower side of the IEGC band i.e 49.90 Hz from 20:30 hrs onwards in view of anticipated frequency rise due to demand reduction at 21:00 hrs.
j. Likewise, all India grid frequency shall be maintained on the higher side at around 21:09 Hrs i.e. 50.15 Hz in view of anticipated drop in frequency due to restoration of load.
k. Primary response of all generating stations shall be in service. All the hydro power plants would reduce their governor droop setting from the current level of 4-5% to 1-2% or whatever lower value feasible latest by 1200 hours of 5th April 2020 and confirm to the respective SLDC/RLDC the revised settings implemented. This would be reverted to the original setting anytime on 6th April 2020.
l. All defense mechanisms such as Under Frequency / df/dt relays and Automatic demand management systems shall be in service and healthiness shall also be ensured.
m. The distributed and diverse actions by the households across the country between 20:45 Hrs to 21:30 Hrs may cause the grid frequency to vary between 49.50 Hz to 50.50 Hz.

C.) Voltage Control measures:

a. Since COVID-19 containment measures implemented from 25th March 2020 nearly 220-240 lines at 400 kV voltage level and above are kept in open condition for voltage control. System voltages have been within the Indian Electricity Grid code (IEGC) band. As per studies during the above event the voltage levels would be within control keeping the generation scheduling as per section-B above. The list of 400 kV and above buses where the voltage level is expected to rise by more than 0.01 pu is indicated at Annexure-III.
b. Notwithstanding the above, all switching operation of transmission lines, line reactors & bus reactors shall be completed by 20:00 hrs. to keep voltages preferably around 760/400kV respectively.
c. All reactors should put in service wherever required, latest by 20:00 hrs .
d. STATCOMS and SVCs shall be in voltage control mode with reference voltage of 400 kV.
e. Capacitors at distribution level to be kept off to maintain voltage at nominal.

f. All thermal and hydro machines would absorb/generate reactive power as per capability curve. It is expected that the operation of hydro units in the 0-10% would increase the reactive power generation/absorption capability.

D.) **General guidelines :**

a. Telephone numbers of all control centers, generating stations and substations under respective jurisdictions of SLDCs, RLDCs and NLDC shall be readily available in control rooms.
b. All regional entities may be advised to maintain their interchange with the grid as per schedule.
c. Reserve Regulation Ancillary Service (RRAS) dispatch instructions for ISGS shall be issued by NLDC to maintain the load-generation balance in real-time.
d. HVDC set points may be kept in a manner such that adequate margin in inter-regional corridors is available and keep Inter/ Intra regional node voltages as suggested above.
e. All SLDCs may advise DISCOMs to avoid any feeder switching operation from 20:00 to 22:00 hrs.
f. Round the clock availability of communication systems & SCADA data shall be ensured by all entities.
g. Strengthening of control room staff may be carried out NLDC and all RLDCs/SLDC shall remain in alert mode and monitor the grid closely in order to take care of any contingency.
h. SLDCs shall advise respective DISCOMs to ensure that distribution substations, housing society/ residential apartments main supply shall not be switched off at feeder / mains level. Necessary direction may also be sent to Resident Welfare Associations (RWA) in this regard. Further, all other lighting loads such as street lighting, colony lights and other essential services including supply to hospitals shall continue to remain in service as per normal practice in the interest of public safety.
i. DISCOMs may be advised to issue prominent messages to general public and municipalities to switch off only domestic lights and all other household loads/appliances shall be used normally.
j. All RLDCs/SLDCs & NLDC are advised to extend the evening shift timings till 22:00 hrs. preferably and allow overlap with the incoming night shift.
k. All the entities shall ensure black start facilities mentioned in the restoration procedures of RLDCs are in healthy condition.

All senior personnel should be available at the generating stations, substations, Load Despatch Centers (LDCs) between 18:00 to 22:00 hrs. on 05th April 2020.

Annexure-I: Anticipated reduction in demand.

Annexure-II : Operating margins for hydro & gas stations.

Annexure-III: List of substations where voltage would rise by 0.01 pu and above during load disconnection

Annexure 2.3 Results of the mock exercise on hydro ramping

RAMP TESTING OF HYDRO UNITS CARRIED OUT IN NIGHT OF 04.04.2020 and in Morning of 05.04.20 with Restoration Details									
S.NO	HPS NAME	TESTING DONE	RAMP DOWN QUANTUM & TIME	RAMP UP QUANTUM & TIME	DROOP SETTING	REMARKS	Present Droop Setting (%)	Droop Restoration Date	Droop Restoration Time (HRS)
1	Chamera - 1	Y	180>20MW/1.03 min	20>180/1.00 min	2%	04.04.20	5	06.04.20	1200
2	Chamera - 2	Y	98>13MW/2.00 min	13>99MW/2.00min	5%	04.04.20	5		
3	Chamera - 3	Y	77.40>8.00MW/104 sec	8.3>76.10MW/104sec	2%	04.04.20	5	06.04.20	1200
4	NJPC	Y	25>275MW/07 min	275>25MW/07min	2%	04.04.20	5	05.04.20	2200
5	Dhauliganga	Y	70>07MW/54sec	07>70MW/58sec	2%	04.04.20	5	05.04.20	2310
6	Bhakra Right	Y	157>20MW/27sec	20>157MW/18sec	2%	04.04.20	5	06.04.20	1000
7	Rampur HPS	Y	110%>Minimum/170sec	Minimum>110%/195sec	2%	04.04.20	5	05.04.20	2300
8	KOLDAM HPS	Y	220>30MW/65sec	30>220MW/75sec	3%	04.04.20	3	No Change	
9	SALAL HPS	Y	115<07MW/42sec	07>115MW/42sec	2%	04.04.20	5	05.04.20	2300
10	Pong	Y	58>0MW/95sec	0>58MW/55sec	3%	04.04.20	4	06.04.20	-
11	Bhakra Left	Y	124>44MW/120sec	44>111MW/52sec	2%	04.04.20	5	06.04.20	-
12	Dehar	Y	165>140MW/26sec	140>165MW/24sec	NA	04.04.20	-		
13	Tehri	y	190>125MW/2 min	125>195MW/2 min	2%	04.04.20	4	06.04.20	1030
14	Koteshwar	y	91.5>70MW/15sec	70/90MW/19sec	2%	**05.04.20**	4	06.04.20	1000
15	Parbati 3	N	NA	NA	2%	**05.04.20**	4	05.04.20	2300
16	Dulhasti	N	NA	NA	2%	**05.04.20**	5	06.04.20	1000

Performance details of Hydro station mock drills received from Maharashtra SLDC

Ramp down/Ramp Up Time of Maharshtra Hydro Power Stations						
Power Station	Capacity per Unit (MW)	Required Minimum Load Per Unit(MW)	Time required to come down to Minimum load from Full Load (Ramp down)	Time required to go up from minimum load to Full Load (Ramp up)	Station Ramp time (time taken from no load to full plant load)	Forbidden Zone
Koyna-I	70	5	1 Min 10 Sec	1 Min 05 Sec	3-4 min	
Koyna-II	80	5	1 Min 10 Sec	1 Min 05 Sec	3-4 min	
Koyna-III	80	65	30 Sec	30 Sec	00:45 Min	
Koyna-IV	250	50	8 Sec	14 Sec	1 min	80-180 MW
KDPH	18	7.5	3 Min	3 Min	5 Min	
TPC-Bhira	25	0	2 Min 55 sec	3 Min	3-4 min	-
TPC-Bhira-PSP	150	110	40 sec	2 Min 40 sec	6 MIN	<100 MW

Sl No	Station Name	Testing Done(Y/N)	Testing Confirmation Mailed?	Ramp-down quantum & time	Ramp-Up quantum & time	Droop setting	Mock Drill Date	Mock Drill Time (From/to)
1	Koyna-I	Y	Y	50 MW to 05 MW -1 Min 10 Sec	05 MW to 50 MW -1 Min 05 Sec	7%	05-Apr-20	11:00 to 12:30
2	Koyna-II	Y	Y					
3	Koyna-III	Y	Y	80 MW to 65 MW 30 sec	65 MW to 180 MW 30sec	4%	05-Apr-20	11:00 to 12:30
4	Koyna-IV	Y	Y	250 MW to 50 MW in 1.08 min	50 MW to 250 MW in 1.39 min	5%	05-Apr-20	11:00 to 12:30
5	KDPH	N	N			NA	05-Apr-20	NA
6	TPC-Bhira	Y	Y	100 MW to 0 MW in 2.55 min	0 MW to 100 MW in 3.0 min	4%	05-Apr-20	11:00 to 12:30
7	TPC-Bhira-PSP	N	N				05-Apr-20	NA

Annexure 4.1 Summary of Reports by SLDCs on Lights Off event

Important actions taken by SLDCs for management of #9pm9min event

Hon'ble Prime Minister of India on 3rd April 2020 at 09:00 AM appealed to the citizens to switch off lights for nine minutes and light diyas, candles, mobile flashes, etc. on 5th April 2020 at 21:00 hrs for 9 minutes to mark India's fight against coronavirus pandemic. As soon as Hon'ble PM has announced the Pan India Lights off Event (9 PM 9 Minute), all Load despatch Centers had started planning of the activities to be taken so that reliable and secure grid operation can be ensured during the 9 PM 9 Minute event.

To ensure the security and reliability of the Indian electricity grid, on 4th April 2020, an emergency meeting of Forum of Load Despatchers (FOLD) was conducted through video conferencing and preparedness of all the SLDCs were discussed in the meeting. After the discussions, POSOCO has issued an advisory elaborating on the measures required to be taken about the generation scheduling, frequency control, voltage control and other general guidelines to be followed by the LDCs during the event. Further, RLDCs had also discussed preparedness/action to be taken with the concerned SLDC so that effective strategies could be made to handle the 9 PM 9 Minute event.

SLDCs in their report has mentioned that the 9 PM 9 Minute event has been given the utmost importance by the Concerned State Government and the event monitored by senior Govt. Officials, head of SLDCs, STUs including the Hon'ble Ministers in few States. Everyone including media has appreciated the efforts of the frontline operators and LDCs for making this event successful.

SLDCs in their reports have detailed the information regarding action taken/observations of the load despatch Centres pertaining to the 9 PM 9 Minute event on 5th April 2020. The important actions/observations, as given in the reports of the Load Despatch Centres, are given below:

Northern Region SLDCs

BBMB

BBMB issued guidelines in line with the POSOCO advisory to its Generation and Transmission stations. Elaborate mock exercise on hydro ramping at BBMB Generating Stations was also carried out on 4th April 2020 night and 5th April 2020 morning in coordination with NRLDC to assess time response for reduction/ increase of load on hydro machines.

Advance actions such as Change of Governor Droop Setting (from 4-5% to 1-2%) for Bhakra & Pong, management of water conduct system of different powerhouses, switching off transmission lines and ensuring reactors in service & capacitors were off were taken prior to the event for keeping frequency, voltages and hydraulic parameters within permissible limits.

Further, actions were also taken to ensure that hydro units should be kept rolling at 0 -10 % of the rating and not to be disconnected during the event. BBMB had also ensured the preparedness of the black-start facility at Bhakra left and right bank to deal with any contingency.

Hydro Generation at Bhakra, Dehar & Pong was maximized at 20:30 hrs. to provide flexibility during 21:00 hrs. event. Loading on machines was reduced during the event by keeping a watch on the Frequency of grid and the same was increased in the same manner accordingly.

Hydro generation of BBMB was reduced from 1878 MW at 20:53 hrs. to 650 MW at 21:03 hrs. i.e. ramp down of 1238 MW in 10 minutes. This translates to ramp-down rate of approximately 123 MW/min. The minimum generation of BBMB during the event was 637 MW at 21:09 hrs.

Due to the high rate of rising frequency and after consultation with NRLDC, unit- 1 of Dehar and Unit-6 of Bhakra Right were desynchronized at 21:02 hrs. and the same were synchronized at 21:15 hrs. and 21:11 hrs. respectively. During the prolonged running on low load, high vibrations on machines of Bhakra Power Houses were observed. The event was managed smoothly without any untoward incident.

Chandigarh

Electricity Wing of Engineering Department UT Chandigarh (EWEDC) had carried out a campaign to only switch off the light and no other household appliances like TV, fridge, fan etc. All the distribution offices in Chandigarh and Municipal Corporation of Chandigarh were also sensitized through suitable advisories. Advisory also includes the provision pertaining to the control of over-voltages during the low demand period.

Based on the historical pattern, the load demand around 9.00 PM was forecasted about 95 MW. EWEDC estimated a load loss of 10 MW during the 9 PM 9-minute event. Thus, the demand was estimated at 85 MW for the time block starting 21:00 hrs. to 21:15 hrs. for 5th April 2020. Accordingly, the scheduling was done with gradual reduction starting with the time block 20.00-20:15 hrs.

The demand of Chandigarh is met from the allocations in the Central Generating Stations (CGS) and through procurement from Power Exchanges. The power demand of Chandigarh at 20.00 hrs. was 125 MW and demand started reducing and by 21.00 hrs. it reduced to 100 MW which reduced

further to the lowest demand of 82 MW at 21:10 hrs. From 21:11 hrs., load started rising up gradually to reach 101 MW at 21.25 hrs.

During the event, no distribution no feeders were switched off and no incident of any breakdown was reported.

Delhi

SLDC issued the Guidelines/ advisory in line with the guidelines issued by POSOCO to STU, State Generators, State DISCOMs, and all the state utilities. Utilities have been advised regarding switching off of capacitor banks, taking of bus reactors, df/dt relays, UFR, transformer tap positions, the opening of lines, no switching of feeders during the event, instructions to RWAs, etc.

In Delhi at 20:45 hrs., demand was 2008 MW and started reducing w.e.f. 20:45 hrs. The minimum demand of 1235 MW was recorded at 21:08:50 hrs i.e. 773 MW drop in Delhi demand during the event with respect to demand of 2008 MW at 20:45 hrs. The demand started picking up and reached to 1979 MW at 21:59 hrs.

SLDC has advised that all the lightly loaded 220kV transmission lines and 66/33kV distribution lines be made off before 20.00 hrs.

During the event, state generators Bawana and Pragati-I were operating on the technical minimum. During the event, Delhi generators maintained their generation as per the capability curve. SLDC along-with its report has also attached the report of the State Generators. During the total period of operation, no tripping was observed and there was no manual feeder tripping reported from the field.

Haryana

SLDC had anticipated a reduction of 500-700 MW of demand during the event. High voltages issues in the system were being faced. The load met during the present COVID-19 lockdown scenario was being managed from Inter-State Generating Stations and none of the state thermal generators were running. Only WJCPS (hydel) was in operation.

To handle this event, a detailed action plan was issued by SLDC on 4th April 2020 afternoon after a conference call with FOLD members and after discussion with all the Haryana Power Utilities i.e. UHBVN, DHBVN, HPGCL and hydropower plant (The West Jamuna Canal Power Station -WJCPS). Utilities have been advised regarding switching off of capacitor banks and taking of bus reactors, df/dt relays, UFR, transformer tap positions, the opening of lines, no switching of feeders during the event, etc.

During the preparatory phase, Haryana SLDC has enumerated the actions to be taken by the generators, Transmission wing, DISCOMs, district authorities, and senior officials of the utilities for the reliable and secure operation of the grid.

Haryana drawl started reducing from 3645 MW at 20:51:36 hrs. and reached a minimum drawl of 2744 MW at 21:09:10 hrs. i.e. The total reduction in Haryana's drawl recorded during the event was 901 MW. Subsequently, from 21:09:10 hrs. the drawl started picking up and settled around 3221 MW at 21:55 hrs.

Hydro generation for Haryana State was maximized by 20:45 hrs. and generation reduction of 764 MW (from 1417 MW to 653 MW) between 20:45 hrs. to 21:10 hrs. (matching with demand reduction of 901 MW during the same period) was achieved with these resources. This hydro generation was again ramped up from 653 MW to 1404 MW from 21:10 hrs. to 21:27 hrs. to meet the increase in demand after the event.

During the event, in coordination with Unified Control Room / HPPC, Panchkula, an extra load that was not scheduled was connected in the system to increase the stability of Grid. The event was managed smoothly without any untoward incident and power system parameters were maintained within permissible limits.

Himachal Pradesh

An advisory was issued to DISCOM, STU and all stakeholders so that actions/ precautions to be taken to avoid grid disturbance and maintain desired grid parameters for reliable & secure System Operation.

All the domestic consumers were requested by DISCOM though Press/Media/ WhatsApp to switch off their lights only and no other appliance in use may be switched off. Also, a short TV message was flashed from HPSLDC Control Room assuring the domestic consumers about the stability, reliability, and robustness of Indian Grid.

SLDC had conducted mock Drill to assess the quick stop & start capabilities and ramping capability of different Hydro Stations in HP. Plants were requested to absorb/ inject reactive power from/ to system as per their capability curve in line with the direction issued by HPSLDC from time to time.

On 5th April 2020, the demand of HP was 621 MW at 08:47 PM which got reduced to 395 MW at 09:09 PM. The total drop in demand 226 MW was recorded during the event. The demand started rising at 09:10 PM and reached 538 MW at 09:14 PM and continued thereafter.

Hydro Generating Stations in the State were kept on the bus with their available generation and ramped down/ ramped up as per the requirement.

To manage the over-voltage, all the capacitor banks were switched off and reactors were kept in service. The voltage at major sub-stations was monitored and it was within limits during the event. All the parallel lines were opened.

During the event, no distribution substation, housing society/ residential apartment main supply was switched off at feeder/ main level. The power system of HP functioned smoothly during the event.

J&K

SLDC had prepared a plan of action and had taken necessary action pertaining to the change in generation schedule, frequency control, voltage control, etc. On the day of the event, there were rains, gusty winds twice during the day. The first storm hit at 1430hrs resulting in a load crash from about 1850MW to 1450MW at 1600hrs and 2nd time it started at 1930hrs resulting in a load crash from 1890MW to 1522MW at 2003hrs. The load had recovered to a high of 1645MW at 2055hrs i.e. 5 minutes before the starting time of light switch off event. The load remained depressed by about 400 MW during the switch off/on event from the normal demand.

The load decreased from 1539 MW at 2100 hrs. to 1481 MW at 2110 hrs. The load drop during the event was 58 MW which was 45% of the expected drop of 130 MW due to bad weather conditions. The load recovered to 1604 MW (pre-switching off range) at 2130hrs.

Because of load crash due to rains and gusty winds, under drawal was managed through surrender from ISGS and State JKPDC generators. Subsequently, J&K remained in over-drawl mostly within 100MW, during the event.

The ISGS and State generators were scheduled from 2115 hrs. to meet the increase in load after switching off event. However, the load crash due to weather did not recoup, which resulted in under-drawl (UD) at 2115 hrs.; consequently, the ISGS was again surrendered to keep UD to a minimum.

The Switch off/on event on 05.04.2020 was managed successfully even though J&K was hit by bad weather, due to which load was depressed by about 400MW with respect to normal demand during the event time block.

Punjab

SLDC Punjab had issued an advisory on 4th April regarding actions/precautions to be taken to avoid grid disturbance & maintain desired grid parameters. All the Unit Heads of Hydro Power Stations in Punjab Control Area were advised to be present in their control room and act as per the direction of Punjab SLDC. Hydro plants were also requested to absorb/inject VAR from/to the system as per their capability curve in line with the direction issued by SLDC from time to time. The generation by State Thermal Generators/Large IPPs was nil

Further, SLDC inter-alia had advised to the stakeholders that all clocks at generating stations may be synchronized to Indian standard time, all switching operation of transmission lines, capacitors, bus reactors, ICTs, to be completed by 20:00 hours, distribution supply shall not be switched off at feeder/mains level.

Punjab's demand was 2995 MW at 20:55 hrs. which reduced to 2396 MW at 21:10 hrs. The total reduction in demand recorded during the event was 599 MW. The demand started picking up and reached 2712 MW at 21:45 hrs.

During the event, available units of Hydro Power Stations were kept on the bus with their full generation. subsequently, depending on the demand crash, the backing down of the hydro generation started. One unit under reserve shut down was kept out of the bus with spinning mode. The hydro generation was reduced to 252 MW at 21:05 hrs. from available 482MW at 20:55hrs and picked up to 425 MW at 21:16 hrs.

Punjab had surrendered 421 MW of power at 09:00 PM from Central Generating stations of to match with load dip. To address high voltage issues, lightly loaded transmission lines were made off during day hours of 05.04.20, and all the capacitor banks were switched off & 400kV reactors were kept in service. The voltage at major sub-stations was monitored and no voltage violation was observed.

Rajasthan

In line with the guideline issued by POSOCO, SLDC issued the separate Guidelines/ Advisory to state generators, DISCOMs, and Grid substations. The advisory includes the provisions pertaining to the awareness to the consumers, switching off of capacitor banks and taking of bus reactors, df/dt relays, UFR, transformer tap positions, opening of lines, no feeder should be opened, etc. SLDC also advised DISCOMs to set up a control room at circle level and one control room at HQ level and availability of senior officials in the control room shall be ensured.

Mock drill of one unit each at JSPS (Jawahar Sagar) & Mahi PH-I Hydro station was carried out in the morning of 05.04.2020 to check the ramping up of units from minimum to maximum rating &

vice versa within minimum time. Further, a control room was set up at Jodhpur to coordinate with the wind developers to trip the pooling station, if grid frequency shoots up beyond 50.2 Hz.

On 5th April 2020, at 20.45 hrs. Rajasthan demand was 5850 MW and demand started reducing and minimum demand of 3689 MW was recorded at 21:10 hrs. The total 2161 MW drop in demand was recorded during the event. Further, the rise in demand was started from 21:10 hrs. and demand reached to 4996 MW at 21:30 hrs.

During the above event, there was no feeder tripping reported from field, and voltages at major substations were within limits.

Uttarakhand SLDC

SLDC had discussed the preparedness of the event with the stakeholders. Subsequently, an advisory was issued to DISCOM, STU, hydro generators, etc. The advisory includes the provisions pertaining to the reactive power management, df/dt relays, SPS, optimization of tap positions at important sub-stations, etc. SLDC had also advised DISCOM to publicize in newspapers or inform consumers through SMS that household equipment like fans, refrigerators, AC, etc. should not be switched off during the 9 PM 9 Minute event. Further, a mock drill was successfully carried out at hydro stations during the day-time on 05.04.2020 to ascertain ramp-up & ramp-down performance of the units.

During the event, the demand of Uttarakhand reduced from 689.68 MW to 464.38 MW i.e. demand reduction of 225 MW against the envisaged demand reduction of 170-200 MW. During the event, generation flexibility was provided by ramping down and ramping up of hydro generation to the desired levels. Moreover, few lines were opened to control the overvoltages, subsequently, Voltage at major substations was within limits. During the event, no undesirable event of equipment failure, over/under voltage tripping, etc. was reported in Uttarakhand.

Uttar Pradesh

The Uttar Pradesh SLDC had estimated that about 3000 MW sharp load reduction may occur during the event. This load reduction was estimated on the basis of load increase during peak hours i.e. from 18:30 hrs. onward. It was assumed that under prevailing weather conditions, the contribution of lighting load in the peaking load is around 80 % (excluding street lights, etc.). But actual load reduction was much higher. Switching-off of distribution feeders have not been reported from any part of the state.

To operate the power grid in a “safe, secure, and smooth manner,” SLDC had issued a detailed advisory on 3rd April 2020 wherein various measures and all technical aspects were included.

To operate the Power grid safely and securely, various utilities were requested to issue appropriate instructions to field officers pertaining to the reactive power management, UFR, df/dt relays, optimization of tap positions at important sub-stations, etc.

In order to achieve load generation balance in real-time and to maintain the frequency of power grid, all generating units have been advised to remain in free governor mode operation, and Generating stations may be scheduled below the technical minimum as per requirement. Further, nodal officers were assigned for each generating station for better communication and coordination to give quick and effective responses for safe and secure operation.

The overall decline in demand of the Uttar Pradesh Control Area during the event was approximately 4800 MW. Demand started reducing from 20:45hrs and minimum demand 8916 MW was recorded at 09:10:24 hrs. Subsequently, from 09:12 hrs. the demand started picking up and settled around 12550 MW at 09:43hrs.

Load generation balance was managed by flexing of Hydro generation, revision of schedules, backing down of various thermal generating plants, etc. And bus Voltages of various substations were strictly monitored and operating point lies within the permissible limit.

The event was managed smoothly without any untoward incident while power system parameters were maintained within permissible limits.

Eastern Region SLDCs

Bihar SLDC

SLDC had advised all stakeholders/field officers to be in alert mode and all instructions issued by SLDC to be followed without any loss of time, and no action to be taken without instructions from the SLDC during the event. The ISGS plants / IPPs were also requested to be alert to ensure quick compliance of any request of surrender/ increase in the schedule in coordination with ERLDC. To control the likely high voltage during the event, the transformer tap position of all running 80 MVA power transformers was changed to the minimum tap position and all the capacitor banks were switched off & 400kV reactors were kept in service.

SLDC has also advised that voltage at major sub-stations be monitored during the event. And some 220 KV/132 KV lightly loaded/idle charged transmission lines were made off to control the over-voltage conditions in the grid. Further, five grid sub-stations from North Bihar & South Bihar each were also identified which can be made off during ramp-up period to avoid overdraw problem.

Although the event was scheduled to start at 9 PM, the demand started reducing from 08:45 PM onwards and continued till 09:09 PM. Bihar demand at 20:50 hrs. was 3,796 MW which was

reduced to 1,680 at 21:09hrs. The total reduction in demand recorded during the event was 2116 MW which was quite high in comparison to the envisaged demand reduction of approx. 650 MW. The demand started picking up and reached 3,563 MW at 21:45 hrs.

During the event, high voltage was observed in 220 KV system at Gaya & Biharsharif. To overcome high voltage issues during ramp-down period, 220 KV Gaya (PG)-Khizersarai D/C T/L isolated from both ends and about 200 MW load was shared by 220 KV Grid Sub Stations Bodhgaya & Biharsharif of BSPTCL.

DVC:

DVC has taken the advance actions such as switching off capacitor banks, taking reactors in service, instruction to thermal power plants to maximize the VAR absorption, and all three units of Maithon HEP and both the unit of Panchet HEP were synchronized.

During the event, the total reduction in DVC demand was 583 MW which was more than the anticipated demand reduction of 200-250 MW. DVC demand started reducing from 20:54 hrs and the minimum demand of 746 MW was recorded at 21:08 hrs. Subsequently, from 21:10 hrs, the demand started picking up and settled around 1220 MW at 21:21 hrs.

During the event, hydro generation (from Maithon HEP and Panchet HEP) was maximized by 20:44 hrs. and generation reduction of 69 MW (from 128 MW to 60 MW) between 20:45 hrs. to 21:10 hrs. was achieved. Between 21:10 hrs. - 21:20 hrs., hydro generation was ramped up from 60 MW to 95 MW to meet the increase in demand after the event. The event was successfully managed by DVC through the utilisation of flexibility provided by the thermal and Hydel generation. DVC has also shared the performances of generating units of DVC along-with its report.

During this event, the maximum voltage recorded in 400 kV, 220 kV, and 132 kV were 417 kV, 232 kV, and 138 kV respectively. DVC has manged the event smoothly without any untoward incident while power system parameters were maintained within limits.

Jharkhand:

An Advisory was issued by MD, Jharkhand Urja Sancharan Nigam Limited (JUSNL) to DISCOM & Transmission Utility on 4th April 2020, in respect of action/ precautions to be taken to avoid Grid disturbance and to maintain desired Grid parameters during the event. All the supply circles in JBVNL(DISCOM) were advised to established a control room, and all 33/11 kV Feeders to be in a charged condition. Instructions were also given to power sub-stations that during 21:00 hrs to 21:15 hrs., no switching operation to be carried out and all capacitor banks to be kept in off

position. Field officers were instructed to ensure proper working of under frequency relay and overvoltage relays. All captive power plants were advised to run on house load.

Jharkhand load was decreased from 1140 MW to 636 MW i.e. reduction of demand in JUSNL command area during the event was 504 MW. JBVNL demand started reducing from 20:45 hrs and minimum demand of 636 MW recorded at 21:09hrs. Subsequently, from 21:10 hrs., demand started picking up and reached 1075 MW at 21:45 hrs. During the event, the maximum recorded voltage in 220kV and 132kV was 231kV and 136 kV respectively in JUSNL Grid system.

During the event, one unit of Subernrekha hydro (SRHP- 2x 65 MW) helped with the flexible generation which varied between 10 MW - 48 MW, and the thermal unit of Tenughat was backed-down to cope with the loss in demand. During the event, there was no feeder tripping report from the field.

Odisha:

Department of Energy, Government of Odisha had issued a press release requesting the consumers of the State to switch off only the lights in a phased manner in order to keep the system stable.

SLDC had issued an advisory for the concerned stakeholders. SLDC advised that all the Unit Heads of Hydro Power Stations be present in their control room during the event and all the available units of Hydro Power Stations to be kept on the bus with their full generation.

Further, SLDC had also advised State Thermal Generators/ IPPs / major CGPs to be available during that period and their senior executive to be present in their control room, and act as per the directions of SLDC. Generators were also requested to absorb/inject VAr from/to the system as per their capability curve in line with the direction issued by SLDC from time to time.

To handle the event smoothly, Odisha had surrendered 879 MW from Central Generating stations of Farakka, Kahalgaon & Talcher. And to address high voltage issues, SLDC advised stakeholders to switch off the capacitor banks, 400 kV reactors to be kept in service, to made off the transmission lines which are idle charged / lightly loaded.

Odisha demand at 20:45 hrs was 3,021 MW which was reduced to 1,731 at 21:10 hrs. The total reduction in demand recorded during the event was 1,290 MW. SLDC in its report has also shared the DISCOM-wise demand details. The demand started picking up and reached 3,010 MW at 21:55 hrs.

Odisha had surrendered 879 MW from Central Generating stations of Farakka, Kahalgaon & Kaniha during that period. And no necessity was felt to back down the State's thermal generation.

During the event, the backing down of the hydro generation started. Three units of Rengali, three units of Upper Indravati, three units of Balimela were kept out of the bus with spinning mode. When the load started picking up, hydro generation was changed from 187 MW at 21:08 to 901 MW at 21:17 hrs. by bringing the spinning machines to the bus.

Voltages at major sub-stations were monitored and no voltage violation was observed in the system.

Sikkim

The anticipated total load reduction was 10 MW for the State of Sikkim. However, the total load reduction during this event was 18 MW. The load started reducing from 45 MW at 20:50 hrs. and kept on reducing to a minimum demand of 27 MW at 21:09 hrs. Subsequently, the demand started picking up and settled around 38 MW at 21:21 hrs.

As per the directions of SLDC, all the distribution system capacitor banks were switched off. As State-owned hydro generating station was off bar, therefore, ramping of these stations was not possible during the event and IPPs operated as per the instruction of ERLDC. The event was managed smoothly without any untoward incident while power system parameters were maintained within limits.

West Bengal

West Bengal SLDC estimated that around 10-12% of the load will be disconnected instantly at 21.00 hrs. Accordingly, a load reduction of 753 MW (WBSEDCL– 623 MW, CESC – 120 MW, IPCL– 10 MW) was envisaged by SLDC.

As per the envisaged load-reduction, load-generation balance planning was done by the SLDC. Accordingly, it was decided to keep all four units of Purulia Pump Storage plant (PPSP) on the bar before 21.00 hrs, and to switch off these machines one after another as per requirement after the occurrence of load reduction. Further, most of the thermal machines were reduced to technical minimum limits before 21.00 hrs. and ISGS shares were also surrendered. It was also decided that during switching on- of lights after the event i.e. after 21.09 hrs., PPSP generators to be brought back and generation to be increased as per the requirement.

SLDC decided to keep all bus Reactors in service and switch off all capacitor banks to maintain the voltage within permissible limits. It was also decided not to switch on/off any circuit or perform any transformer tap-change operation during the load switching off/on period unless an extreme emergency occurs.

The maximum load rejection for West Bengal occurred at 21.09 hrs. The maximum load reduction was 2025 MW (WBSEDCL– 1692 MW, CESC – 326 MW, IPCL– 7 MW). The demand started picking up and settled around at 22:10 hrs.

Moreover, SLDC, in its report, has also shared the sub-station wise load reduction details of different WBSETCL sub-stations.

Western Region SLDCs

CHHATTISGARH

SLDC had discussed the preparation of the event with DISCOMs officials and the probable impact of switch-off of lighting load on the total demand of the state. Further, CSPDCL has issued a press note urging the people to only switch off light load.

Based upon the guidelines issued by NLDC, a joint action plan for reliable & secure grid operation was prepared under the guidance of MD(CSPTCL) and MD(CSPGCL) and issued on 04.04.20 to the Generating stations, Distribution centres and SLDC. A load loss of about 200 MW was anticipated during the event.

Considering the low demand in the state after lockdown, backing down of generation to the tune of 155-200 MW in CSPGCL thermal units was planned from 20:45 hrs. and all 03 units of only available hydro plant (3x40 MW) in the state were kept in operation before the scheduled operation at 2045 hrs. Hydel Station was asked to Ramp-down/Ramp-up as per the frequency trend of the system. Further to cope with low demand persisting in the state, central sector shares in ISGS were reduced and power was scheduled only from Sipat, KSTPS, and TAPS-II.

The demand started reducing from 2877 MW at 20:45 hrs. and touched a minimum of 1947 MW at 21:09hrs i.e. demand dropped by 930 MW against the anticipated value of 200 MW.

During the event, voltages at all 400 KV substations were maintained within permissible limits by absorbing maximum VAR in Generating stations and switching off Capacitor banks at Transmission & Distribution stations. Moreover, during the event, no tripping occurred in Transmission or also no major tripping reported in the Distribution system.

Daman &Diu (DND)

Electricity Department, Daman & Diu had estimated a load reduction of 12 MW - 15 MW. Accordingly, preventive measures were taken as per the guidelines issued by NLDC.

Preventive Measures which were taken prior to the event are given below:

- 11KV Capacitors were kept in off condition and Low voltage capacitors installed in distribution transformers were switched off.
- Tap position of 220KV and 66KV Transformers were optimized to maintain low voltage.
- All the streetlights were kept on.
- All the Electricity Department staff including engineers, station operators and line staff was in the alert mode to address any problem.
- Switching operations of any equipment to be avoided from 20:00hrs to 22:00hrs.

The demand was 60 MW at 20:50hrs. and minimum demand of 45 MW was recorded at 21:07 hrs. i.e. total reduction in recorded during the event was 15MW. Subsequently, from 21:10 hrs, the demand started picking up and reached 60MW at 21:30hrs. There was no feeder interruption during this period at any sub-station in Daman & Diu.

Dadra & Nagar Haveli (DNH)

Electricity Department had estimated a load reduction of 20 MW - 25 MW. As per the guidelines issued by POSOCO, the department has taken following preventive measures:

- All 220/66 kV transformers tap were kept at minimum position to maintain voltages.
- All capacitor installed at the consumer level was asked to take off.
- Municipalities and Zilla panchayat were asked to keep the streetlights ON during the event. DNHPDCL had circulated awareness messages to consumers to keep all other electrical apparatus on during the event.
- Gas and Nuclear station were scheduled as per advice given by WRLDC.
- All the Electricity Department / DNH Power distribution corporation staff including engineers, station operators, and line staff were in alert mode to address any problem. They were also informed to avoid any switching operation of any equipment from 20:00hrs to 22:00hrs.

The demand was 77 MW at 20:50hrs. DNH demand started reducing from 20:50 hrs. and minimum demand of 50 MW was recorded at 21:06 hrs. The total reduction in DNH demand recorded during the event was 27 MW. Subsequently, from 21:10 hrs, the demand started picking up and reached 76 MW at 21:30hrs. Further, there was no feeder interruption during this period at any sub-station in DNH.

Goa

Chief Electrical Engineer had issued a press note requesting the citizens of Goa to switch-off only their domestic lights and keep the other domestic loads ON during the period, and at the same

time assured the people that the Electricity Grid is robust and that the Grid Stability would be maintained during the period.

Goa had estimated a load drop of around 16-20 MW during the switching-off period. After discussions with the stakeholders, Chief Electrical Engineer had issued an advisory to control the over-voltages and other actions to be taken for safe secure, and reliable operation of the grid. Advisory also instructed that distribution substations/housing societies/ residential apartment's main supply should not be switched off at feeder/mains level.

In coordination with WRLDC, SLDC, Goa had also identified the loads to be put-off in case of grid frequency dropping below 49.6Hz during the period from 21:00hrs to 22:00 hrs. esp. when the domestic load would suddenly come.

The actual drop in demand of Goa during the event was 133 MW. The drop in demand started from 20:45hrs onwards and full loads normalized only at around 22:00hrs.

The actual lighting load that builds during the evening peak hours in Goa is around 70 MW. This includes domestic lighting load plus the streetlight load. But the drop was almost equivalent to 40-45% of the domestic load. Hence the drop in demand of Goa during the switching-off event was similar to the load drop at pan-India level. The demand pattern in the distribution area has been studied by Goa and it is found that there were no 33kV and 11kV trippings during the event which may have also possibly contributed in drop in demand.

The drastic drop in demand in Goa during the switching-off event was mainly due to the fact that people putt-off their entire load of the household instead of only the lights. This could have been due to general apprehension among the public as was being propagated in social media that there would be high voltage in the grid which could damage the appliances.

Gujarat

SLDC Gujarat, after a brief discussion with the stakeholders, had prepared an action plan and advised all stakeholders to follow the same during the event. SLDC envisaged that State demand would remain around 9000 MW at 20:00 hrs.

As the expected lighting load in the system is around 1200 MW. The anticipated load drop due to Hon’ble PM’s appeal would be in the range of 800-1000 MW for just nine minutes. Further, SLDC has advised the following to the stakeholders:

- State-owned thermal/Hydro/IPP plants would maintain regulating margin around 1050 MW.

- Thermal and gas units were advised for backing down around 20:50 hrs. and Hydro units at 20:57 hrs.
- Gas stations advised to come up on bar in between 20:00 hrs to 20:30 hrs with a minimum 5 to 10 MW load in open cycle. It was expected that it would provide around 180 MW additional margin for quick picking of the generation when load light load will restore suddenly.
- The Central sector generators / Short term purchase were scheduled/planned in such a way that there shall be over drawl of around 300-400 MW from 8:30 to 9:15 at State periphery.
- All GETCO field officers were advised to monitor the system voltage closely at 66 kV level substations. If required, the transformer tap may be changed accordingly and capacitor banks to be switched off / on.
- All on bar generators advised to keep governor, PSS and AVR in service. Also, the presence of conversant staff during this specific period to be ensured.
- Hydro and Gas generators were advised not to reduce their generation if frequency falls below 49.7 Hz.
- 10 numbers of 220 kV lines were made off to limit the overvoltage and bus reactors were taken in service.

At 20:50 hrs., Gujarat demand was 8581 MW, and demand started decreasing from 20:54 hrs. At 20:55 hours, Gujarat demand was 8382, and demand reduced to 6800 MW at 21:08 hrs. Total of 1607 MW load drop was observed in Gujarat system. During the event, wind injection was also reduced from 1077 MW to 473 MW. The event was handled in a smooth manner with the cooperation of all Stakeholders. SLDC in its report has shared the details of change in generation from different Sectors and Unit wise generation regulation break up.

Madhya Pradesh

MP SLDC in consultation with DISCOMs had anticipated the demand reduction of about 2100 MW. Further, SLDC envisaged demand of 7250 MW at 21:00 hrs., accordingly, a plan was made for curtailment of 2100 MW generation at 21:00 hrs. to maintain the grid parameters within permissible limits.

At 20:23 hrs, the MP demand was 7128 MW and it started decreasing slowly. At 20:59 hrs the demand of MP was 6248 MW and decreased to 4860 MW at 21:09 hrs. Thus, the total decrease in demand from expected demand was **2390 MW**.

The major challenge for SLDC during the event was to maintain the voltage level within permissible limits. In MP, high voltage scenario persists due to large geographical area and location of drawal

points all over the State. High voltages persist even during high demand period i.e. when demand is 14000 MW during the Rabi Season. To address this, MP SLDC had advised utilities to take out all the capacitor banks installed in the distribution network and transmission network before 18:30 hrs. and all reactors to be taken into service in the afternoon. And some of the lightly loaded lines were opened before 19:00 hrs. to maintain the 220 KV/132 KV/ 33 KV bus voltages close to their rated values. Moreover, all Thermal & Hydel Generators were absorbing MVAR from the grid i.e. running in leading mode.

With the decrease in MP demand from 20:23 hrs., total 2642 MW generation was back down/curtailed. SLDC had back down 1737 MW of State-owned generation (Thermal- 325 MW, Wind- 170 MW, Hydel-1242 MW) and curtailed 905 MW from Central Sector / IPPs / Sardar Sarovar to maintain the pace with the reduction in demand.

The grid voltages in transmission and DISCOMs networks were well within the operational limits. SLDC in its report has also mentioned that no feeder of EHV/ LT network was opened due to grid constraints and there was no supply curtailment during the event.

Maharashtra

Maharashtra SLDC issued a detailed action plan to be followed by all the stakeholders. And SLDC had anticipated 1700-1750 MW demand drop during the event.

On the morning of 05.04.2020, an elaborate mock exercise in coordination with WRLDC, Koyna HPS & TPCL authorities was successfully conducted to ascertain the response of Koyna & TPC hydro generator. Results of the mock exercise are given in the report submitted by SLDC. Further, MSLDC had prepared an execution plan for Control room staff, and the same was shared with Load Management cell, MSEDCL, TPC PSCC & AEML Control Centre for coordinated action.

All Wind generators through QCAs were directed to operate on Voltage control mode & ensure the Over frequency settings of the Wind turbines to be 50.2 Hz. This was to enable the hand tripping of the wind generators in case the frequency goes beyond 50.2 Hz.

The state demand recorded at 20:45 is 13346 MW. The State demand dropped to a minimum of 9924 MW at 21:10 hrs. The total demand reduction for the whole State was 3422 MW @21:10 hrs. with respect to demand recorded at 20:45 hrs. Demand reduction for MSEDCL was 2920MW at 21:10 hrs while for Mumbai it was 507MW at 21:09.

All the flexible resources viz. Hydro/ Gas were utilized efficiently and effectively to match the demand drop/rise during the period between 20:45 hrs to 21:15 hrs.

Due to high-frequency alarm, out of total 80 Nos. of Wind PSS, some WTGs of 13 Nos. of PSS tripped manually. The Total installed capacity of these PSS is 1191 MW. Being low wind generation period and partial tripping of WTGs, total wind generation of 139 MW was cut off during the period of 20:58 hrs. to 21:15 hrs.

The System voltages remained <=793 kV, <=435 kV for 765 kV & 400 kV level respectively due to the prior event activities such as switching off of transmission lines, taking reactor in service, disconnecting Capacitor & significant absorption of MVAR by the generating units during the event. Also, no EHV element tripping is reported during the event.

The event was managed smoothly without any untoward incident while power system parameters were maintained within limits. No major breakdowns or power failures were reported during the above period.

Southern Region SLDCs

Andhra Pradesh, SLDC

AP SLDC advised DISCOMs to intimate the consumers to switch off the lights only and not to switch off the mains & other gadgets during the event. SLDC had anticipated a demand reduction of about 600 MW during the event.

To control the possible over-voltages during the event, SLDC ensured that capacitor banks were cut off prior to the start of the event at 21:00 hrs. Advised all the Thermal, Hydel, and Wind generators to absorb the reactive power. Further, some of the 400KV lines which normally carry light load were identified and kept open to contain the rise in voltage.

In the State, Thermal Generation was kept at the Technical minimum and there was a reduction of about 200 MW in thermal generation. Further, about 500 MW of CGS share was surrendered and power purchases were reduced by 600 MW in 85th Time block.

It is observed that the demand started falling from 20:56 hrs @ 100 MW for each minute up to 21:00hrs and from 21:01 hrs the fall is about 292 MW. The total fall in the generation is about 1530 MW from 20:53hrs to 21:09 hrs. The fall in demand was much higher than the anticipated fall in demand of 600 MW because some of the consumers switched off the main supply in their homes. As such the anticipated demand fall of 600 MW gone up to 1530 MW during the event. The demand started raising from 21:10 hrs. The demand ramp is met from hydel generation.

To manage the reduction of demand, daily scheduled Agriculture demand from 21:00 hrs is about 1000 MW which was rescheduled and advanced to 20:30 hrs. The Agriculture demand reached

1000 MW by 21:00 hrs. About 1000 MW of hydel generators were put into service in order to cope up the ramping of Agricultural demand.

The Voltage at the 400KV system was seen around 412 to 415 KV during the event. Light loaded lines in the 220KV system were also hand tripped.

Karnataka

SLDC forecasted State demand around 8000 MW at 21:00 hrs. and anticipated demand reduction of around 800 MW during the 9 PM 9-minute event.

In line with the advisory issued by POSOCO, a detailed advisory was issued by SLDC to all the Generators/ Electricity Supply Companies (ESCOMs)/ KPTCL Transmission Zones/ other stakeholders about the actions to be taken for safe and secured operation of the grid during the event. Additionally, nodal officers were also nominated for all generating stations, STU stations & lines, and ESCOMs Control Centres.

As a measure to mitigate the high voltages in the system during the event, ESCOMs were instructed to prepone the three-phasese power supply to irrigation pump feeders, due to this about 310 MW inductive load was added to the system. Further, all the capacitor banks were switched off, 400 kV line reactors were closed by 20:45 hrs., and all generators had been requested to absorb reactive power to maintain the nominal system voltages.

Due to wind & rainfall in the state on 05.04.2020, demand was reduced in the evening to an extent of 900 -1000 MW. The demand started reducing from 7673 MW at 20:55 hrs. to 6434 MW at 21:11 hrs. The total reduction in state demand during the event was 1239 MW, and demand started picking up from 21:12 hrs.

During the event, when the grid frequency raised above the limit (50.05 to 50.26Hz), State has overdrawn to an extent of 900-971 MW to maintain the grid security. State thermal generation was back down, CHS share was surrendered, and hydro generation was kept at the maximum at 20:40hrs. Further, wind generation was reduced to an extent of 440 MW when the frequency raised to 50.20 Hz. The details of the change in State/ ESCOMs demand during the event are given in the report of the SLDC.

Kerala

As per the advisory issued by POSOCO, prior to the event - all hydel generators were on the bar with full schedule. SLDC had envisaged the demand reduction of about 350 MW demand during the event.

SLDC had anticipated the demand of around 3400 MW during the event. However, the actual demand met was in the range of 2750-2800 MW. The difference in the demand met was also attributable up to some extent to the lightning thunderstorms in most parts of the State.

The demand started reducing from 2737MW at 20:45hrs and touched a minimum of 2178 MW at 21:09 hrs. Considering the variation in frequency, it appears that the actual demand reduction due to lighting load switch-off started from 2679 MW at 20:52 hrs to 2208 MW at 21:04 hrs. Accordingly, 470 MW reduction was observed in the demand out of which around 335 MW reduction had occurred between 20:53 hrs and 21:03 hrs.

Demand variation, during the event, was managed by flexing the hydro generation from 1261 MW at 20:45 hrs to 556 MW at 21:09 hrs., and by the surrender of 650 MW CGS/LTA share.

During the event, system reactive power requirements were well managed and the Bus voltages at 400 kV SS were maintained within the prescribed limits. Moreover, no feeders/ elements were switched off during the event and all system parameters were maintained within limits.

Puducherry

In line with the Hon'ble Prime Minister's appeal, Hon'ble Chief Minister of Puducherry had also appealed to the people of Puducherry to switch off their lights at 21:00 hours of 5th April 2020 for 9 Minutes.

The unrestricted demand of Puducherry under normal conditions during this time of the year- is around 400- 410 MW. During lock own, the unrestricted demand is around 225 to 230 MW. The demand of Puducherry is met from the allocations in the Central Generating Stations (CGS) of the Southern Region. The maximum allocation to Puducherry from the CGS is 552 MW. Besides, power from the 32.5 MW State-owned combined cycle Gas Power Plant of Puducherry Power Corporation Ltd. is also available.

The electricity department had anticipated a 45-50 MW reduction in demand during the event. However, around 53 MW of load reduction was observed during the event. The drop in demand was much higher than anticipated mainly due to switching off all appliances by a sizeable number of households. This drop in demand was managed by flexing the generation from Combined Cycle Gas Power Plants and lesser requisition from the CGS for the 84th and 85th-time blocks.

At 21:15 hrs., generation at the Combined Cycle Gas Power plant was increased to the normal generation of 27.5 MW. The overall demand also gradually picked up after 21:15 hours.

Tamil Nadu

In the State of Tamil Nadu, series of meetings were conducted by Hon'ble Minister of Electricity and CMD, TANGEDCO with Directors of TANGEDCO / TANTRANSCO and SLDC Official to ensure the security and reliability of the electricity grid during the event. Subsequently, instructions were issued to be followed by the concerned officials during 9 PM 9 Minute event.

Further, a Press release was also issued to make awareness among consumers to only switch off the light and not any other electrical household appliances during the event.

The demand reduction for Tamil Nadu was estimated at 1514 MW. In line with the discussions held in the FOLD meeting; SLDC anticipated that the consumers may switch off other electrical appliances also, so SLDC had made an action plan to manage the demand reduction up to 2000-2200 MW. Accordingly, in advance, a timeline was prepared by SLDC in anticipation of a reduction in demand to the tune of 2000 MW. The action plan includes the provisions pertaining to the (1) backing down of wind generation from 20:45 hrs and wind generation should become zero @ 20:50 hrs. and curtailed wind generation should start to flow in the grid from 21:30 hrs. (2) The flexible generation should be carried out in hydro generation based on the real-time condition of the grid. Two units from Kadamparai should come into service as a pump at 20:45 hrs. (3) 400 MW from CGS generation to be surrendered during the time block 20:45 to 21:00 and 21:00 to 21:15 hrs. etc.

During the event, Tamil Nadu schedule from ISTS was reduced from 8176 MW to 7096 MW between 20:45 to 21:15 hrs and the schedule reduced by making IEX purchase to zero from 450 MW at 21:00 hrs, 450 MW of CGS power was surrendered, and 180 MW of URS availed power was canceled. Thus, a total demand fall of around 2200 MW was balanced successfully and continuous power supply was extended to all the consumers of Tamil Nadu. Load-generation was balanced through, hydro generation was ramped down and again ramped up as per requirement and Kadamparai units were put in pump mode one by one (2 units) from 20:45 hrs to act as load (200 MW). Further, at 20:45 hrs, wind generators in both Erode and Madurai Sub LDC was backed down to Zero.

During the event, to control the high voltage, few 400 KV feeders were opened, Capacitor Banks in 230 KV SS, 110 KV SS and 33 KV SS were switched off, and Reactors were kept in service in 400 KV SS to absorb VAR.

Telangana

Telangana SLDC has identified Reactive Power Management, Load Generation Balance, and Coordination among Grid entities (Genco, Transco, DISCOMs &IPPS) were the critical issues to be managed during the 9 PM 9 Minute event.

SLDC advised all State generators to absorb the maximum reactive power as per their capability curves, and RGMO in service to be ensured.

Further, SLDC advised all Zonal Chief Engineers to ensure switching off capacitor banks, reactors would be in service, monitoring of voltage patterns at all sub-stations, suitable changing of Taps of Power Transformers, healthiness of all protection system and DG sets to be ensured, etc. Additionally, SLDC had also coordinated with the Irrigation Department to switch on Lift Pumps (Medaram) as per the instruction of the SLDC.

Both Major Hydel Generating Stations, Srisailam and Nagarjunasagar were advised to operate the units in generation/pumping mode/ condenser mode depending on the necessity, in Real-Time Basis, as per the advice of SLDC.

SLDC anticipated a reduction of 500-700 MW in demand during the event. However, a contingency plan was made to handle any fall in demand even to the extent of 1370 MW during the event. SLDC planned to meet the less demand during the event by reducing 350MW purchase from Exchange, planned to add 420 MW Nagarjuna Sagar pump, and 120 MW Medaram Pumps (KLIS) and flexing of the Srisailam Hydro Generation and by reducing CGS & State Thermal Generation.

Demand started reducing from 7445 MW at 20:47 hrs. and minimum demand recorded was 6228 MW at 21:09 hrs. i.e. reduction in demand was 1442 MW. From 21:10 hrs., demand started picking up and settled around 6900 MW at 21:40 hrs.

Srisailam Left Bank & Nagarjuna Sagar hydro plants supported the event by bringing the Generators/ pumps in time for making the event successful. The event was managed smoothly with the extension of 50% Agriculture load (about 1300MW) from 1700 hrs. onwards to stabilize voltages. Further, 220KV/ 400 kV lines were opened in co-ordination with SRLDC to control the voltages in the network.

North Eastern Region (NER)

Arunachal Pradesh

SLDC Arunachal had carried out the campaign through social media and other locally available means not to switch off discriminately all the appliances. All the distribution units in the districts were also sensitized through suitable advisories.

SLDC had issued a detailed advisory pertaining to the generation schedule, frequency control, voltage control, and general guidelines to be followed by the stakeholders during the event.

Based on the historical pattern of power demand, the load demand around 9 PM was forecasted as 60 MW, and SLDC estimated a load loss of 30 MW for the time block starting 21:00- 21:15 hrs. for 5th April 2020.

Under the State sector, Arunachal Pradesh has only one Hydro Station with an installed capacity of 24 MW. SLDC had advised this Hydro Station to contribute to the extent possible as per its firm capacity and scheduled at 6 MW from 20:00 hrs. to 22:00 hrs. but in actual it had contributed only 4 MW.

The State demand was 66.45 MW at around 19:45 hrs., the demand started reducing gradually from 20:00. By 21:00 hrs., demand reduced to 43.04 MW and continued to reduce further to the lowest demand of 29.31 MW at 21:07:51 hrs. The total reduction in demand during the event was 28.61 MW. From 21:08:57 hrs., load started rising up gradually and reach 50.52 MW at 21:19:54 hrs.

Assam

SLDC had envisaged 1115 MW load at 21:00 and expected load reduction would be around 200-300 MW. During that period, only available hydroelectric generating plant KLHEP was shut down due to annual maintenance. NTPS and LTPS generating plants were requested to keep their generation at a minimum.

SLDC had anticipated that 9 PM 9 Minute event may lead to the rise of voltages at different sub-stations of Upper Assam areas. To control the overvoltage in the upper Assam area, SLDC requested NERLDC to advise generators to reduce their generation and absorb reactive power.

During the event, total load reduction was around 500 MW which was quite high in comparison to envisaged demand reduction of 200-300 MW. The wide gap between the actual and anticipated reduction of demand may be likely attributed to the apprehension in the minds of the consumers about abnormal voltage rise during the event. Therefore, consumers had switched off their main switch i.e. with lighting loads they had also disconnected all the gadgets/TV/refrigerators, etc. The event was managed smoothly without any untoward incident and power system parameters were maintained within limits.

Manipur

SLDC had prepared an action plan for the reliable and secure operation of the grid during the event. Manipur SLDC anticipated a 35-40 MW reduction in demand during the event.

During the day of the event, Load started reducing from 93.65 at 20:50 hrs. to 51.92 MW at 21:08 hrs. During the event, Manipur load varied between 68.46 MW to 52.76 MW.

During the event, the reduction of demand was 23 MW. Demand reduction of 23 MW was arrived by SLDC while considering the demand met on 4th April 2020 (D-1 demand) and reduction in load in Kakching, Thoubal, Elangkangpokpi and Chandel areas due to tripping of 132 kV lines.

Meghalaya

In line with the advisory issued by the POSOCO, SLDC had taken necessary actions and advised all stakeholders about the action to be taken about preparation for the 9 PM 9-minute event.

State demand started reducing from 189 MW at 20:55 hrs. (Schedule drawal = 149 MW, Actual Drawal = 105 MW, SSGS generation = 84 MW**),** and demand touched a minimum of 152 MW at 21:05 hrs. i.e. demand reduction of 37 MW was observed during the event.

At 21:00 hrs due to sudden rise in the system frequency, and on immediate consultation with NERLDC, generation was immediately reduced to 33 MW. All synchronized Hydro generators were running at leading power factor and facilitating MVAR absorption to reduce the voltage at all nodes. System Voltages at important sub-stations were maintained within prescribed limits. From 21:10 onwards, Meghalaya Load was normalized in coordination with NERLDC.

Mizoram

Restricted peak demand of the State is around 135 MW. The state is having small consumption and a very small generation except for 60 MW Tuirial HEP owned by NEEPCO.

As per the advisory of the NLDC, Tripura SLDC has taken the precautionary measures to avoid grid disturbance; dispatch, and distribution of demand in the event of schedule fluctuations; ramping down of Tuirial HEP generation, etc.

Mizoram SLDC anticipated a 45-50 MW reduction in demand during the event. The data recorded in connection with the lights off event are as follows:

- Actual load (demand) at 20:45 hrs - 65.53 MW
- Minimum load at 21:10 hrs - 61.44 MW
- Total load reduction - 4.09 MW
- Recorded highest voltage - 134 kV at 21:05 & 21:10 hrs
- Recorded lowest voltage - 130 kV at 20:45 hrs
- Tuirial HEP generation - 19.84 MW at 20:45 hrs
- Ramping down of generation - 15.03 MW at 21:00 hrs
- Reduction of Tuirial HEP generation - 4.81 MW

The event was managed smoothly without any untoward incident and power system parameters were maintained within limits. Senior Officers were also on duty in the SLDC Control Centre/ substations/ Customer Care Centre to immediately tackle and solve any contingencies.

Nagaland

SLDC had circulated Advisory issued by POSOCO to Transmission Division and Electrical Division and they were requested to adhere to the instructions of SLDC during the event.

The State of Nagaland usually has a demand of around 100 MW. During the day of the event, Load started reducing from 20:45 hrs. from 88.5 MW to 44.3 MW at 21:03 hrs i.e. demand reduction of 44 MW was observed during the event.

During the 9-minute duration, Nagaland load varied between 44 MW to 49 MW. To manage the load loss, Nagaland surrendered 20 MW for 21:00 – 21:15 hrs. time block, and as per NERDC request - state-owned generation (Likimro HEP) which was generating 6 MW at that time was backed-down.

The minimum voltage of 133.255 KV was observed at 20:45 hrs, and Maximum voltage observed in the system was 138.407 KV at 21:09 hrs.

Tripura

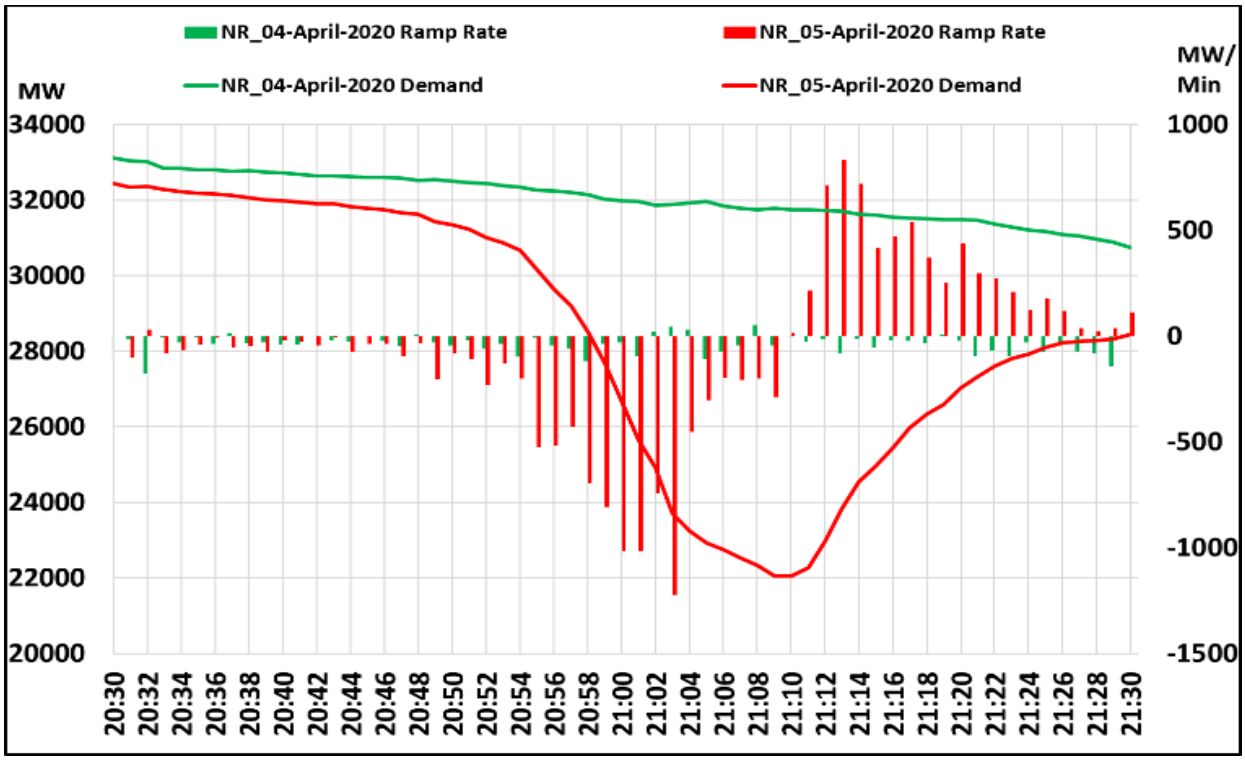
Tripura SLDC anticipated a 45-50 MW reduction in demand during the event. Prior to the event, for keeping voltages within permissible limits, SLDC advised generators to take action so that absorption of VAR would take place.

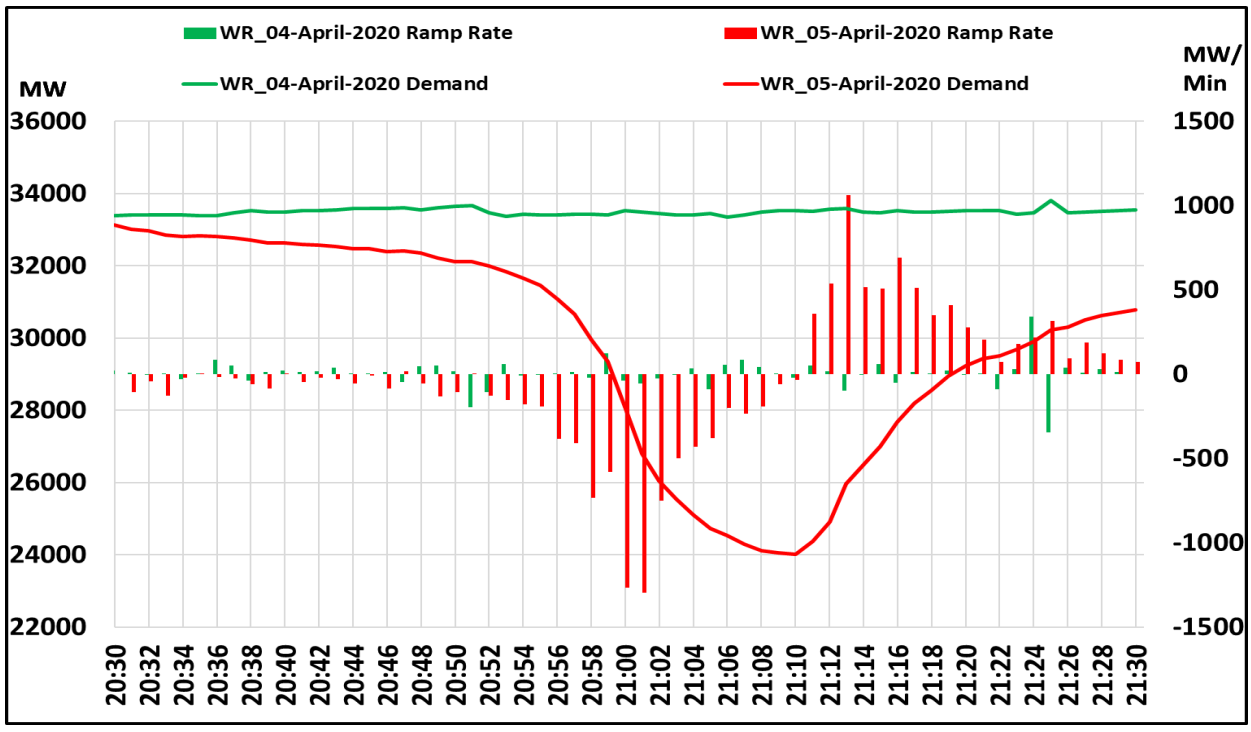
Demand started reducing from 20:55 hrs. and minimum demand of 81.33 MW was recorded at 21:09 hrs. The total recorded demand reduction during the event was 80 MW. Subsequently, from 21:10 hrs., the demand started picking up and settled around 146 MW at 21:33 hrs.

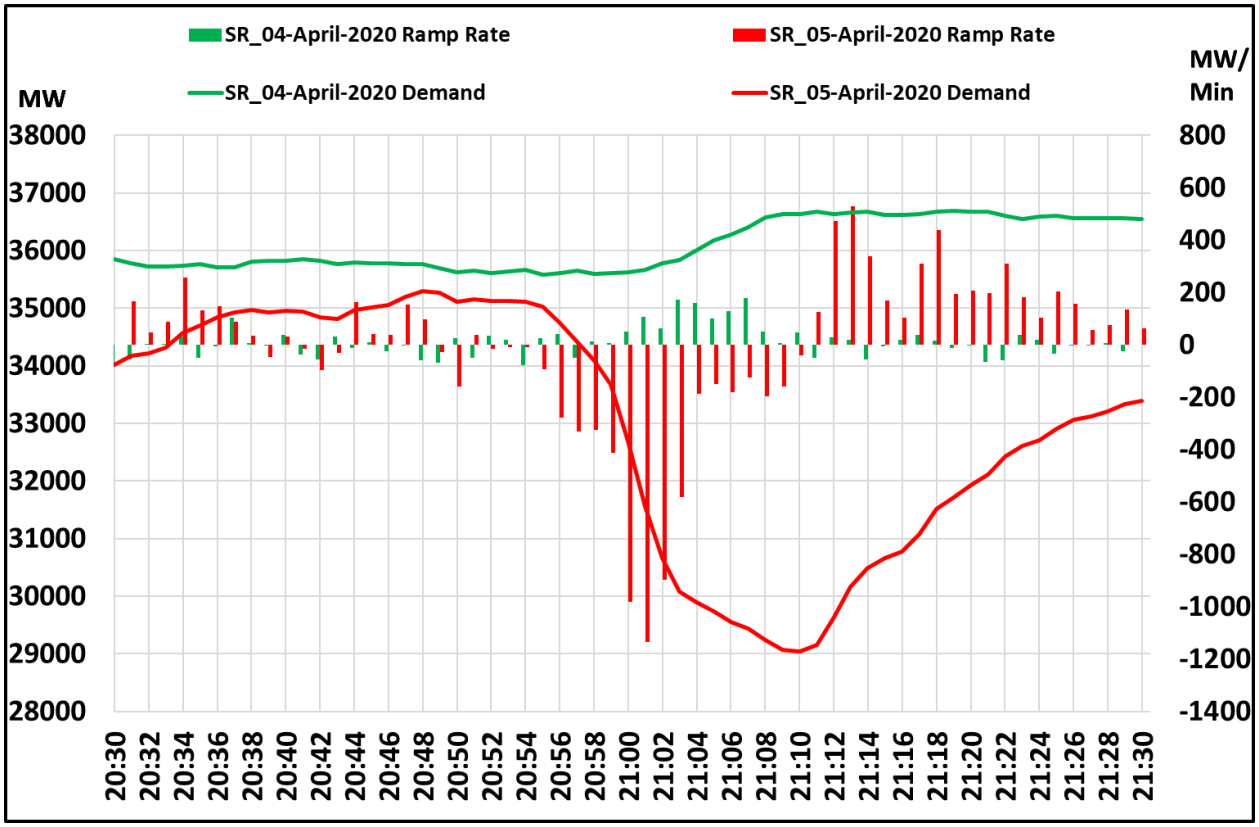
The maximum and minimum voltage recorded at 132KV are 133.47 KV and 132.25 KV respectively in TSECL Grid system during this event. The event was managed smoothly without any untoward incident and power system parameters were maintained within limits.

Annexure 5.1 Regional and State Demand Plots

5.1.1 Trend of Regional and State Demands



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SR_05-April-2020 Ramp Rate
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MW/ Min
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35000
34000
33000
32000
31000
30000
29000
28000
800
600
400
200
0
-200
-400
-600
-800
-1000
-1200
-1400
20:30
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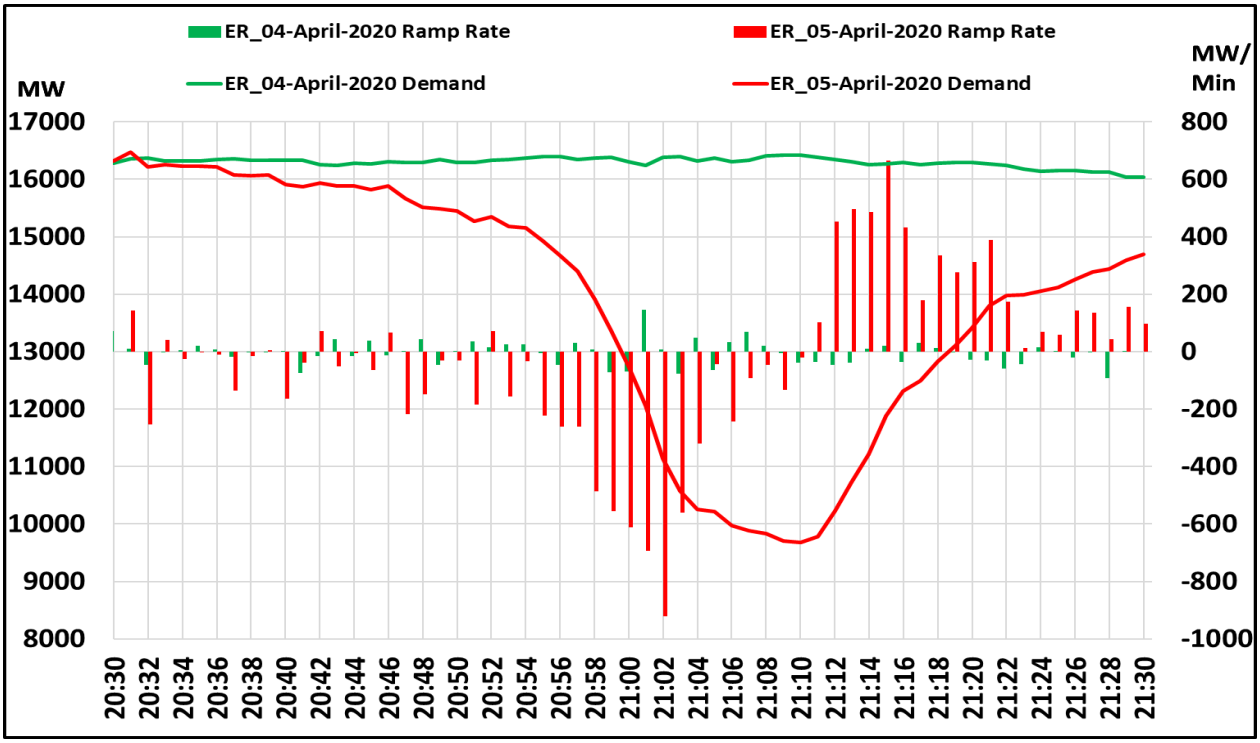
ER_04-April-2020 Ramp Rate
ER_05-April-2020 Ramp Rate
ER_04-April-2020 Demand
ER_05-April-2020 Demand
MW
MW/ Min
17000
16000
15000
14000
13000
12000
11000
10000
9000
8000
800
600
400
200
0
-200
-400
-600
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-1000
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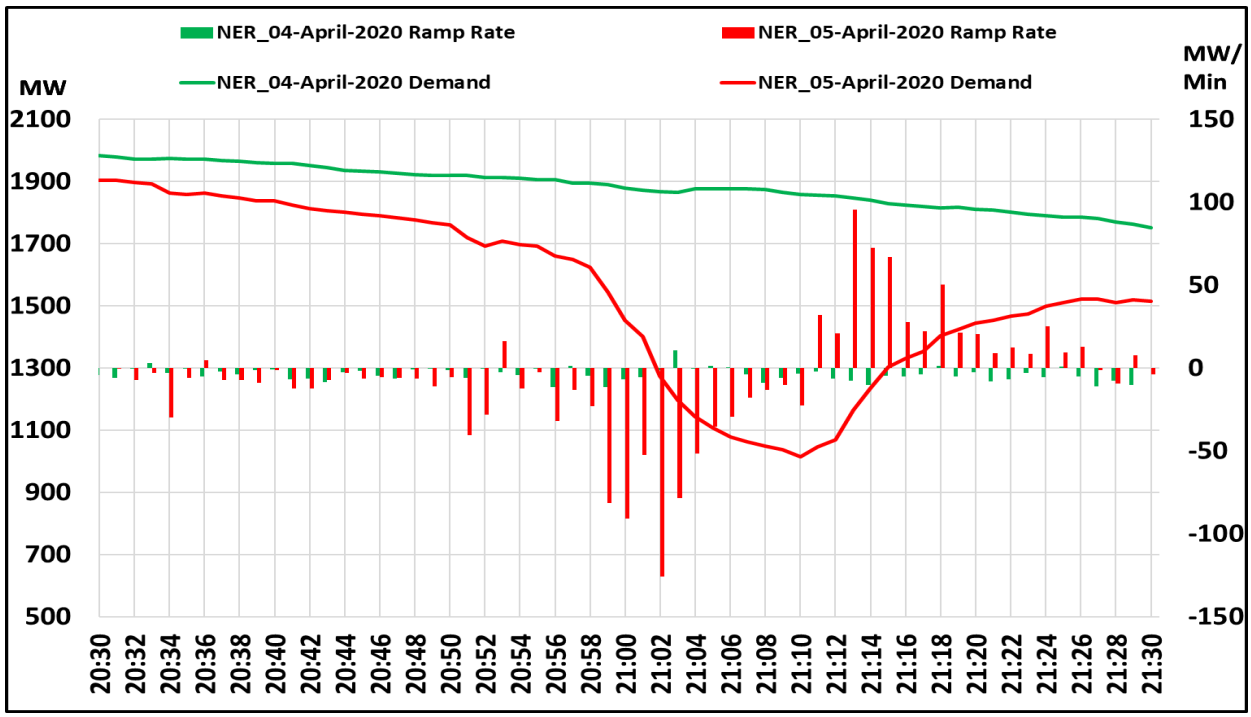
NER_04-April-2020 Ramp Rate
NER_05-April-2020 Ramp Rate
NER_04-April-2020 Demand
NER_05-April-2020 Demand
MW
MW/ Min
2100
1900
1700
1500
1300
1100
900
700
500
150
100
50
0
-50
-100
-150
20:30
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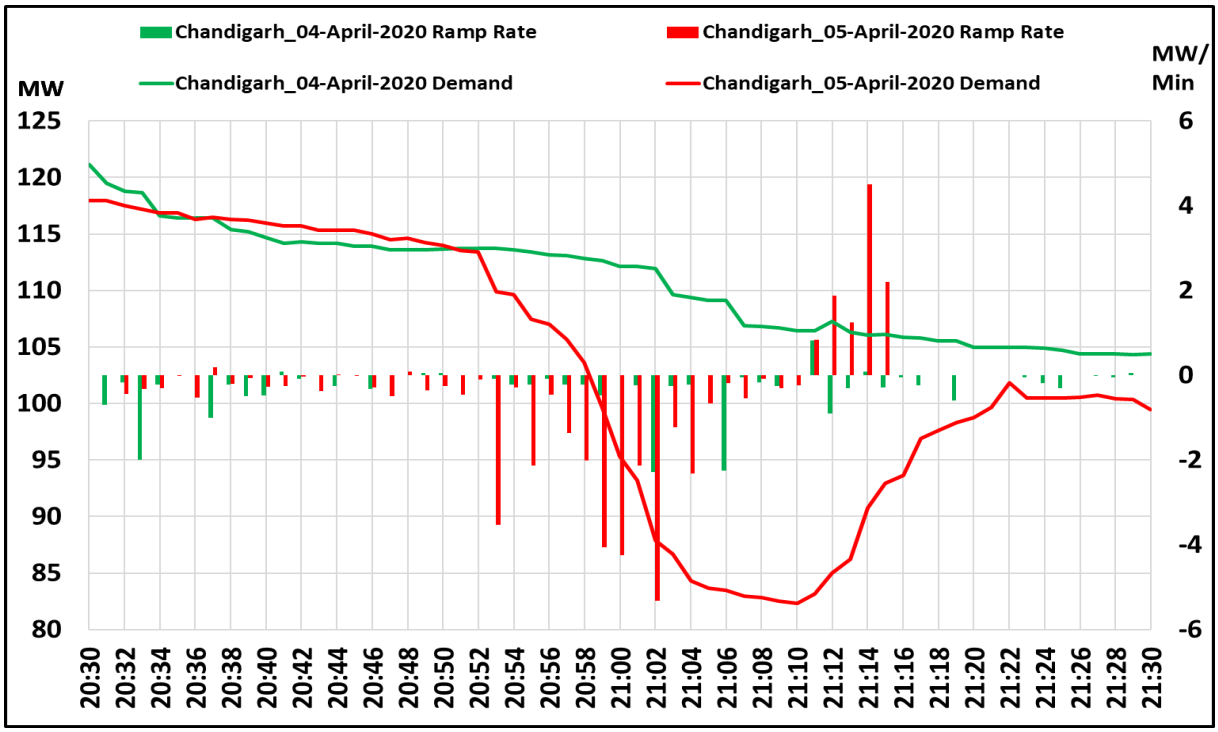
Chandigarh_04-April-2020 Ramp Rate
Chandigarh_05-April-2020 Ramp Rate
Chandigarh_04-April-2020 Demand
Chandigarh_05-April-2020 Demand
MW
MW/ Min
125
120
115
110
105
100
95
90
85
80
6
4
2
0
-2
-4
-6
20:30
20:32
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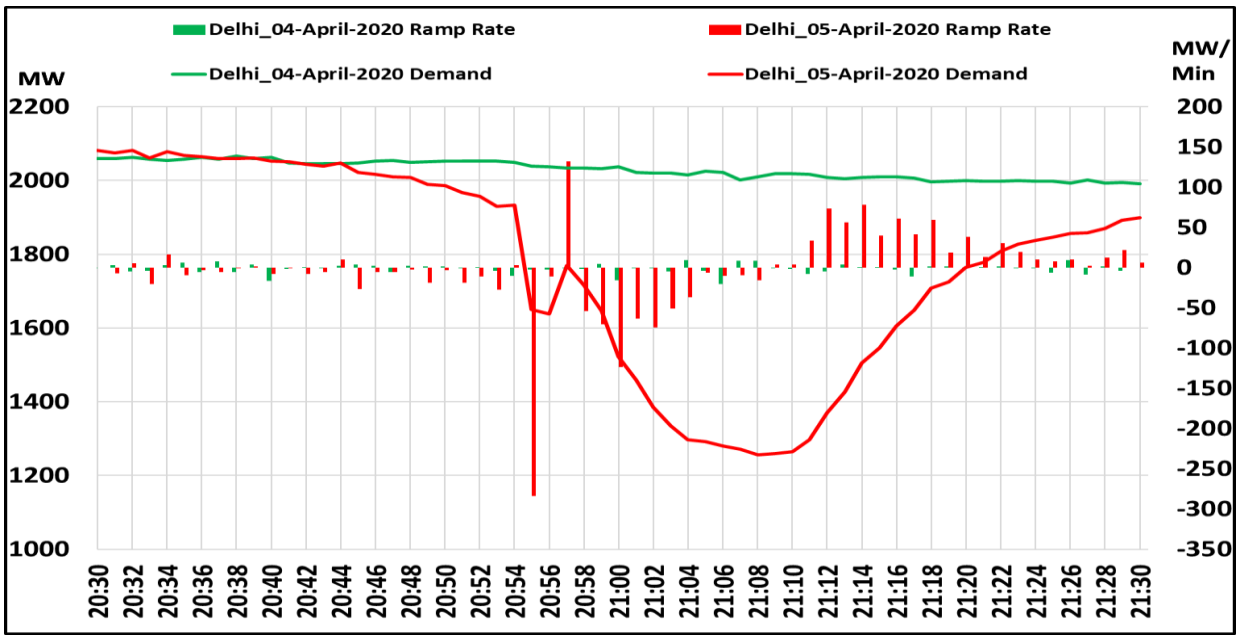
Delhi_04-April-2020 Ramp Rate
Delhi_05-April-2020 Ramp Rate
Delhi_04-April-2020 Demand
Delhi_05-April-2020 Demand
MW
MW/ Min
2200
2000
1800
1600
1400
1200
1000
200
150
100
50
0
-50
-100
-150
-200
-250
-300
-350
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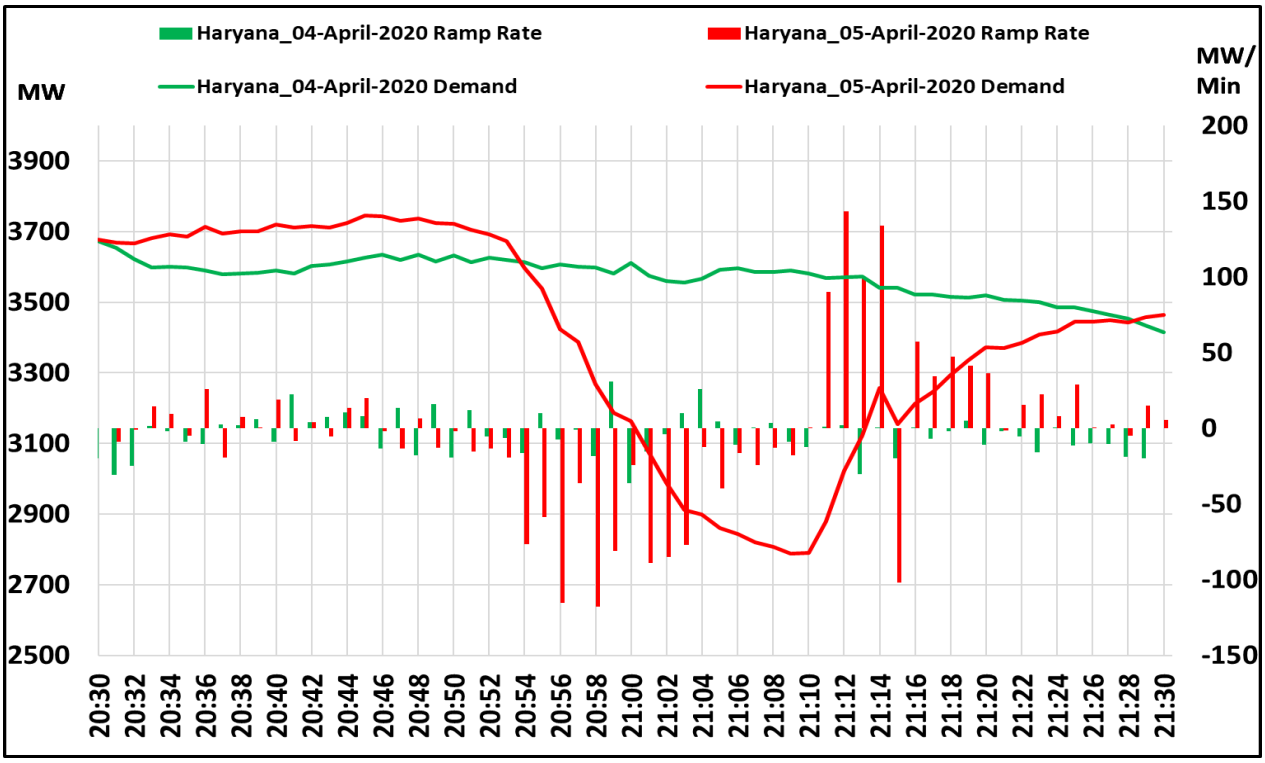
Haryana_04-April-2020 Ramp Rate
Haryana_05-April-2020 Ramp Rate
Haryana_04-April-2020 Demand
Haryana_05-April-2020 Demand
MW
MW/ Min
3900
3700
3500
3300
3100
2900
2700
2500
200
150
100
50
0
-50
-100
-150
20:30
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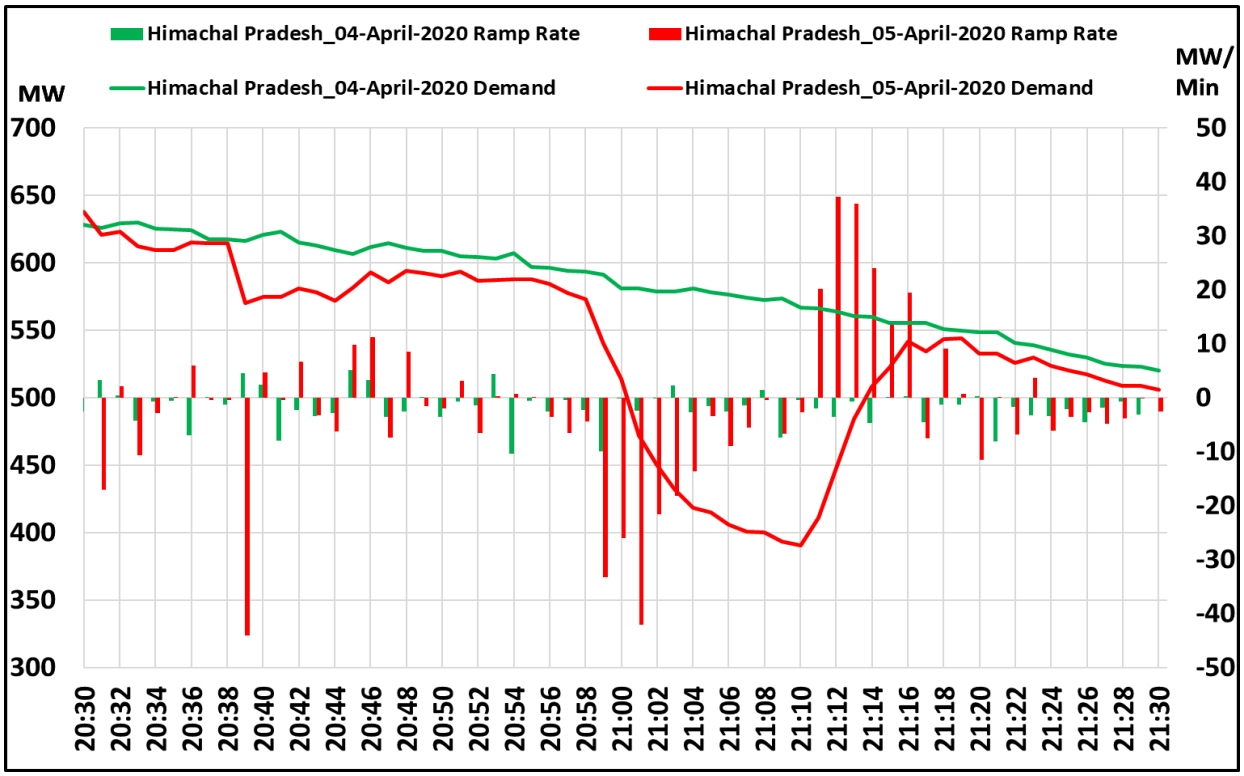
Himachal Pradesh_04-April-2020 Ramp Rate
Himachal Pradesh_05-April-2020 Ramp Rate
Himachal Pradesh_04-April-2020 Demand
Himachal Pradesh_05-April-2020 Demand
MW
MW/ Min
700
650
600
550
500
450
400
350
300
50
40
30
20
10
0
-10
-20
-30
-40
-50
20:30
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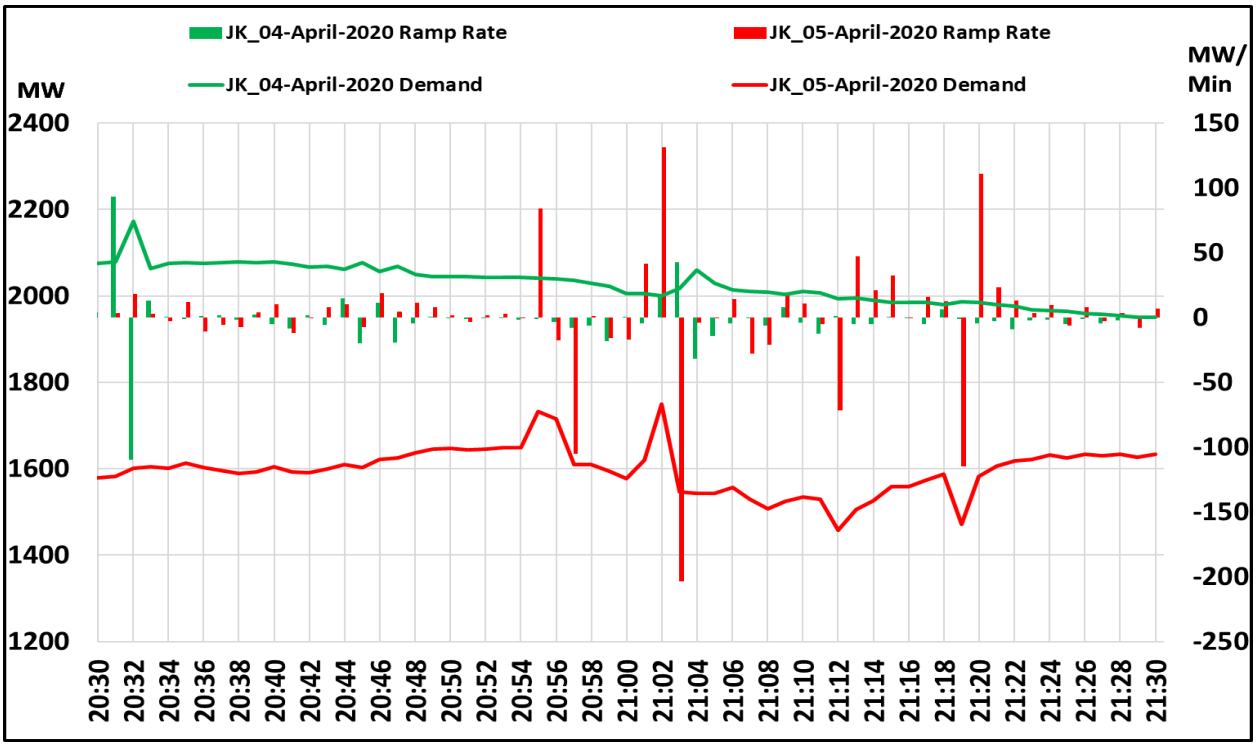
JK_04-April-2020 Ramp Rate
JK_05-April-2020 Ramp Rate
JK_04-April-2020 Demand
JK_05-April-2020 Demand
MW
MW/ Min
2400
2200
2000
1800
1600
1400
1200
150
100
50
0
-50
-100
-150
-200
-250
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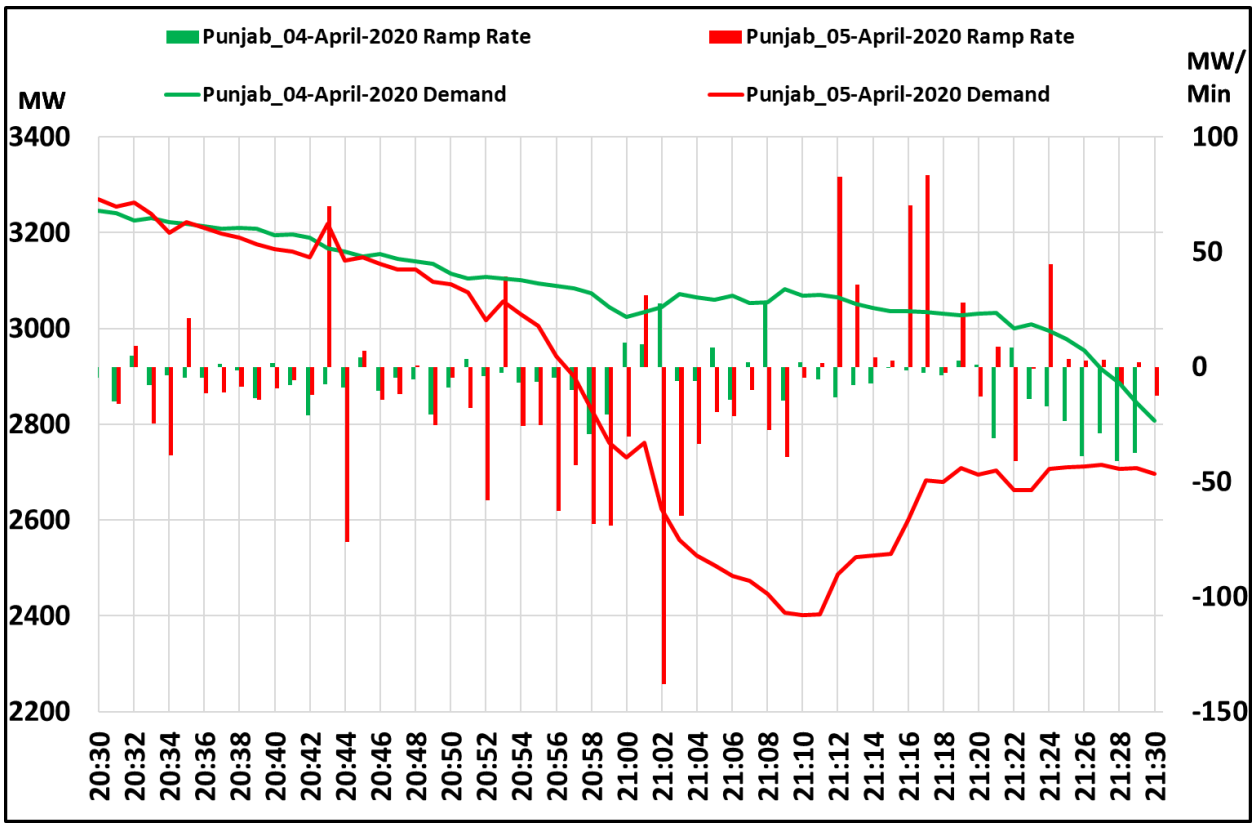
Punjab_04-April-2020 Ramp Rate
Punjab_05-April-2020 Ramp Rate
Punjab_04-April-2020 Demand
Punjab_05-April-2020 Demand
MW
MW/ Min
3400
3200
3000
2800
2600
2400
2200
100
50
0
-50
-100
-150
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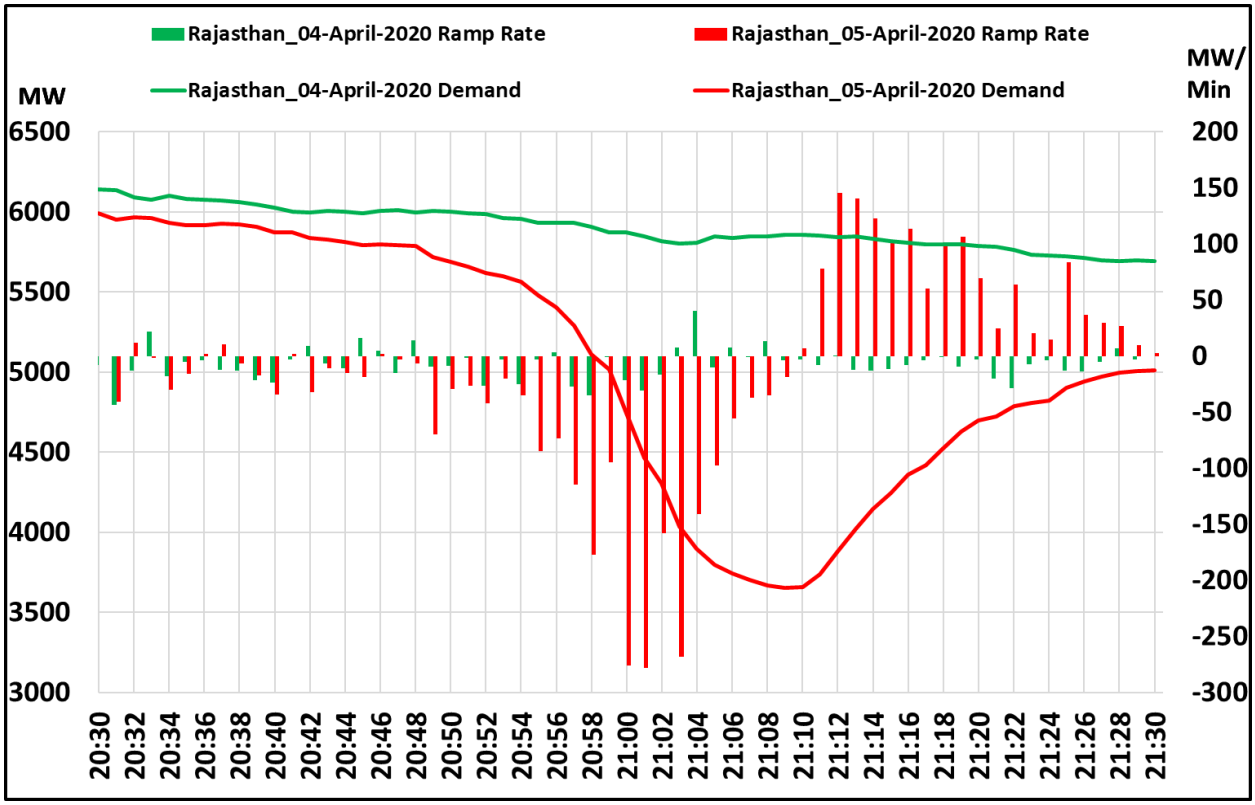
Rajasthan_04-April-2020 Ramp Rate
Rajasthan_05-April-2020 Ramp Rate
Rajasthan_04-April-2020 Demand
Rajasthan_05-April-2020 Demand
MW
MW/ Min
6500
6000
5500
5000
4500
4000
3500
3000
200
150
100
50
0
-50
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-150
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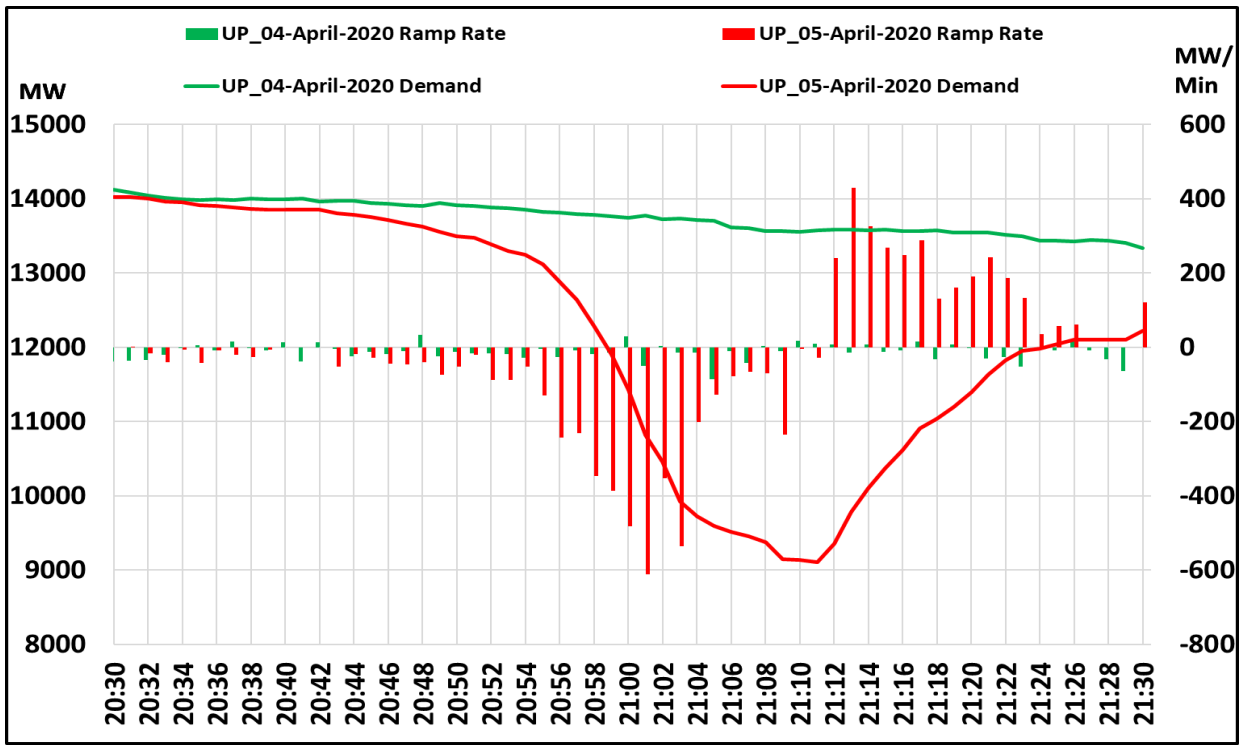
UP_04-April-2020 Ramp Rate
UP_05-April-2020 Ramp Rate
UP_04-April-2020 Demand
UP_05-April-2020 Demand
MW
MW/ Min
15000
14000
13000
12000
11000
10000
9000
8000
600
400
200
0
-200
-400
-600
-800
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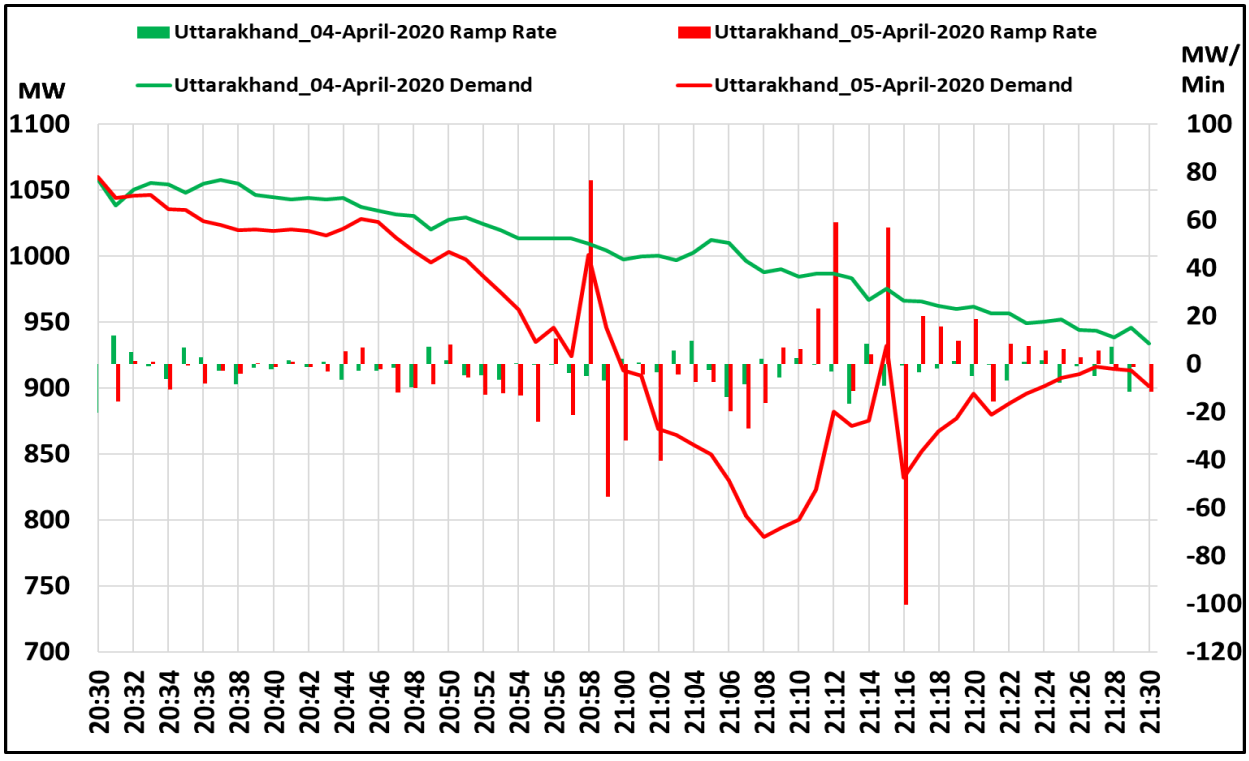
Uttarakhand_04-April-2020 Ramp Rate
Uttarakhand_05-April-2020 Ramp Rate
Uttarakhand_04-April-2020 Demand
Uttarakhand_05-April-2020 Demand
MW
MW/ Min
1100
1050
1000
950
900
850
800
750
700
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
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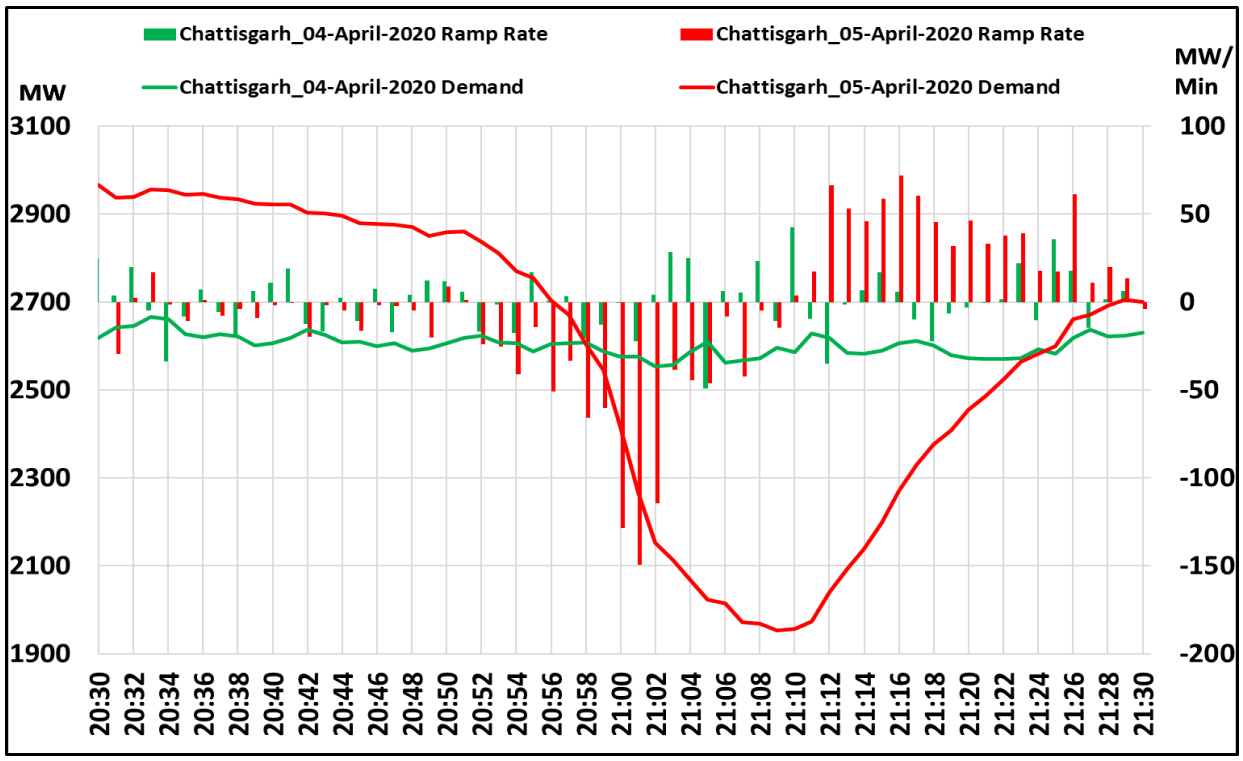
Chattisgarh_04-April-2020 Ramp Rate
Chattisgarh_05-April-2020 Ramp Rate
Chattisgarh_04-April-2020 Demand
Chattisgarh_05-April-2020 Demand
MW
MW/ Min
3100
2900
2700
2500
2300
2100
1900
100
50
0
-50
-100
-150
-200
20:30
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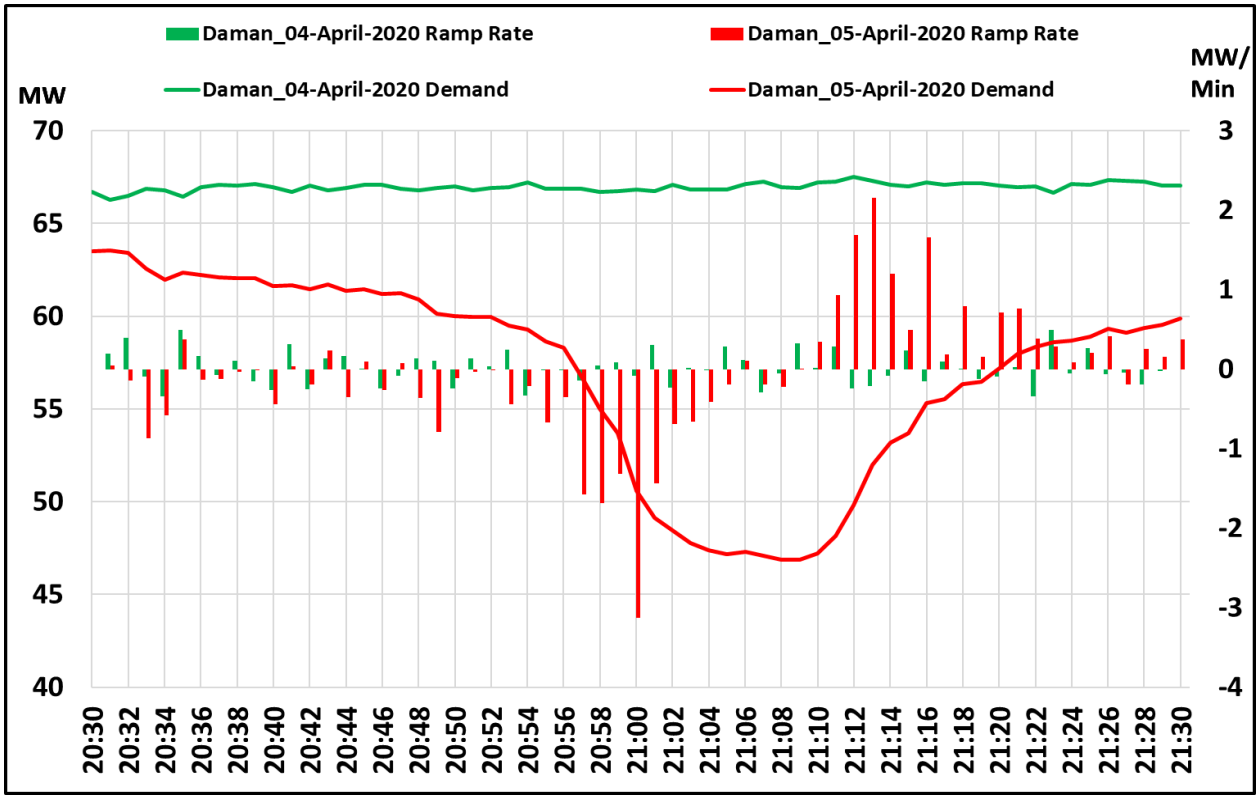
Daman_04-April-2020 Ramp Rate
Daman_05-April-2020 Ramp Rate
Daman_04-April-2020 Demand
Daman_05-April-2020 Demand
MW
MW/ Min
70
65
60
55
50
45
40
3
2
1
0
-1
-2
-3
-4
20:30
20:32
20:34
20:36
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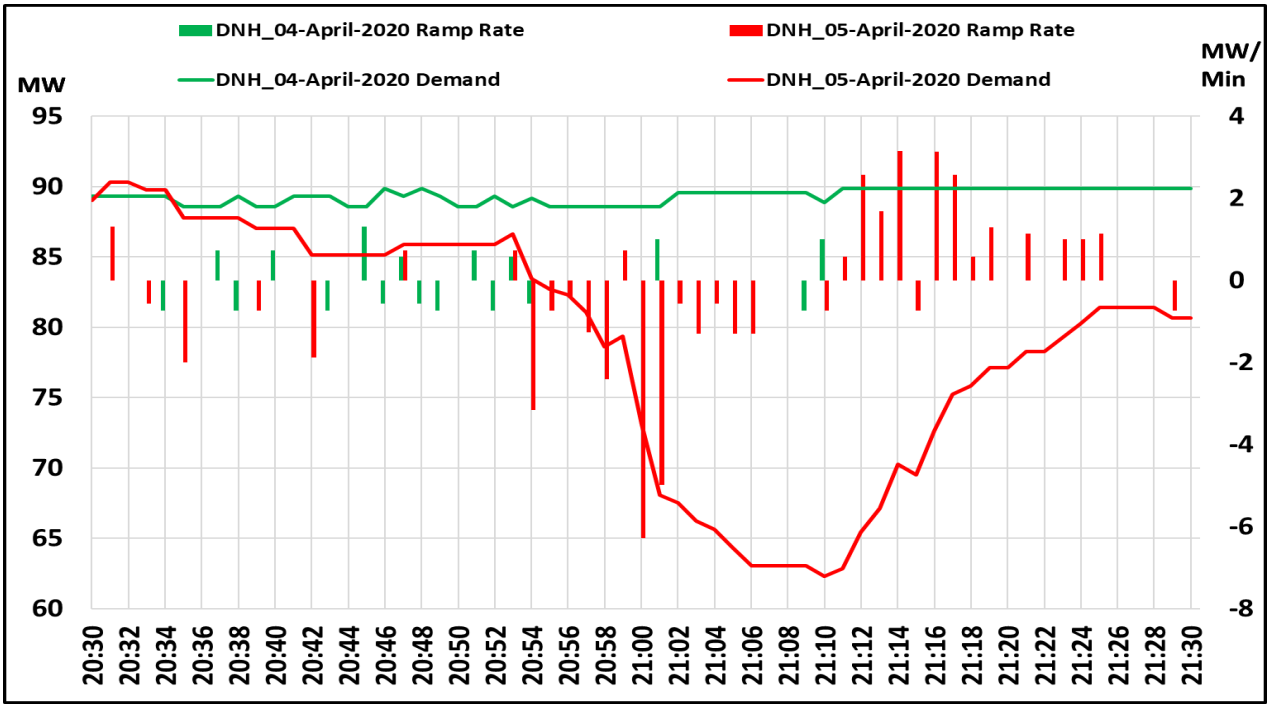
DNH_04-April-2020 Ramp Rate
DNH_05-April-2020 Ramp Rate
DNH_04-April-2020 Demand
DNH_05-April-2020 Demand
MW
MW/ Min
95
90
85
80
75
70
65
60
4
2
0
-2
-4
-6
-8
20:30
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20:34
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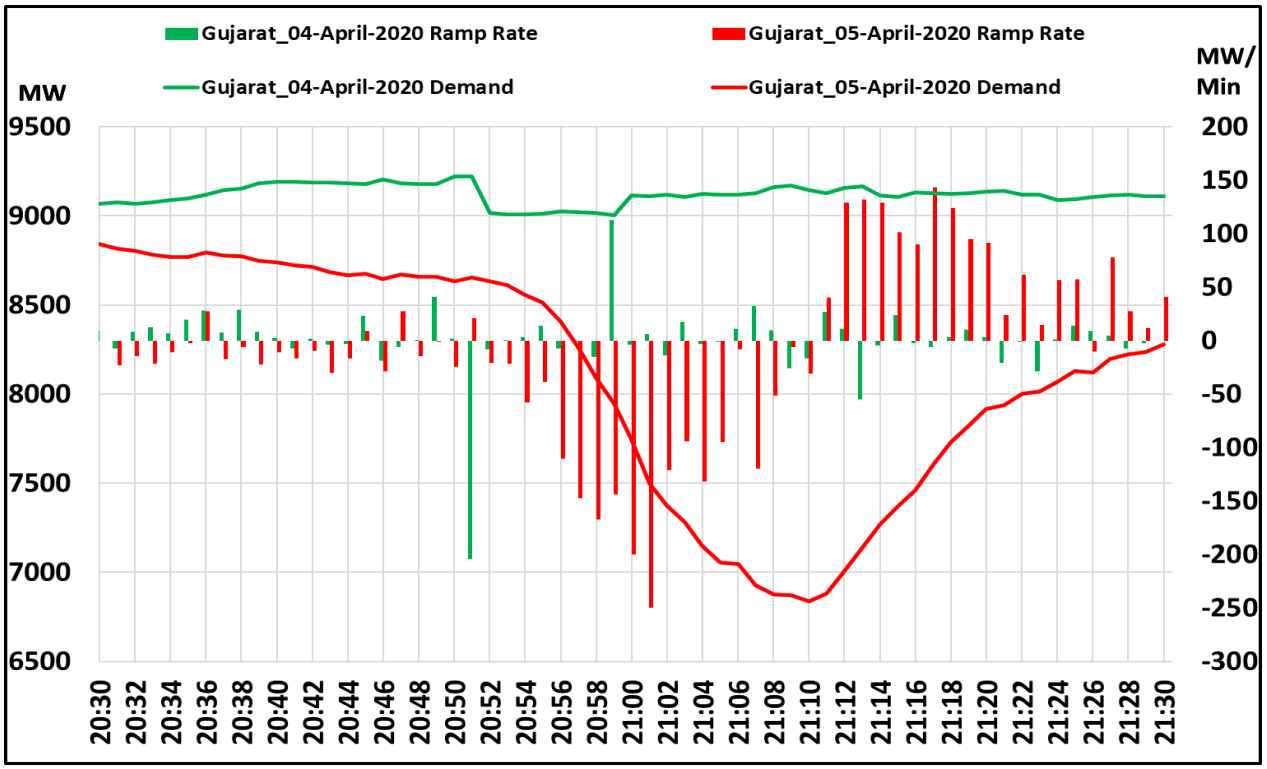
Gujarat_04-April-2020 Ramp Rate
Gujarat_05-April-2020 Ramp Rate
Gujarat_04-April-2020 Demand
Gujarat_05-April-2020 Demand
MW
MW/ Min
9500
9000
8500
8000
7500
7000
6500
200
150
100
50
0
-50
-100
-150
-200
-250
-300
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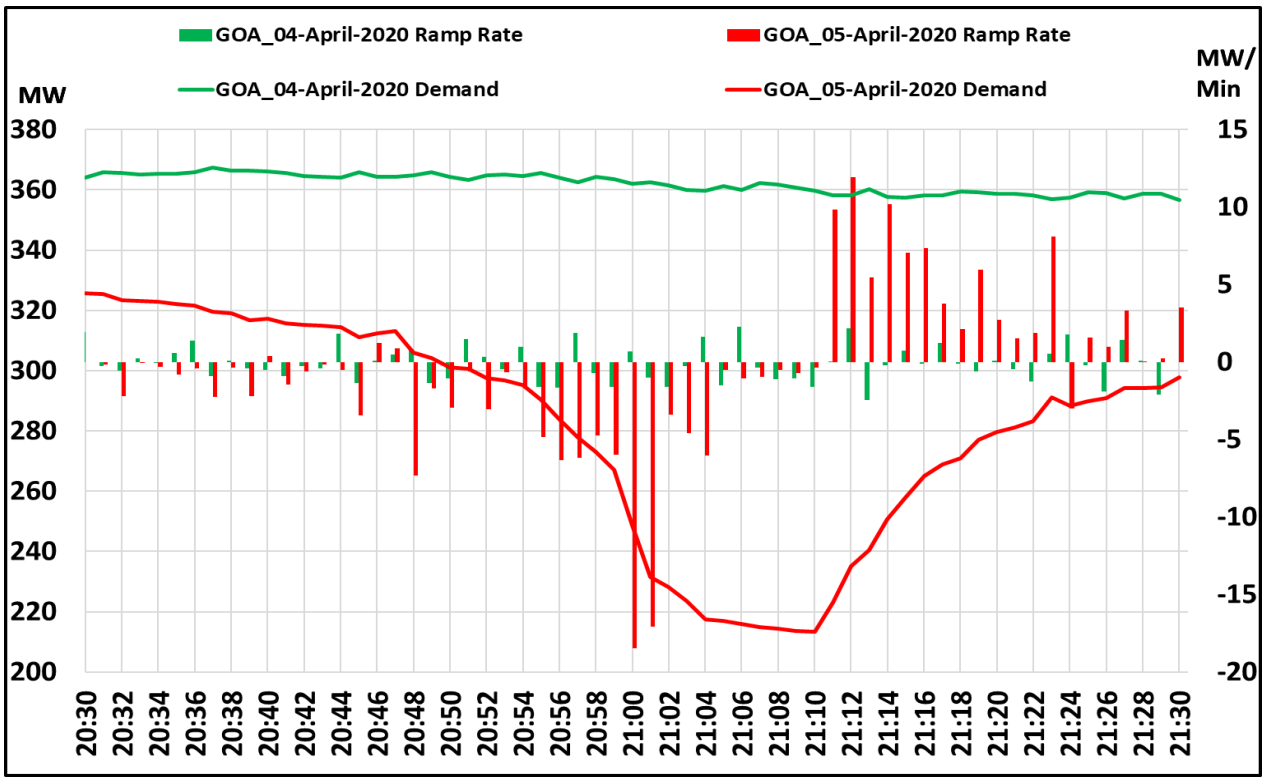
GOA_04-April-2020 Ramp Rate
GOA_05-April-2020 Ramp Rate
GOA_04-April-2020 Demand
GOA_05-April-2020 Demand
MW
MW/ Min
380
360
340
320
300
280
260
240
220
200
15
10
5
0
-5
-10
-15
-20
20:30
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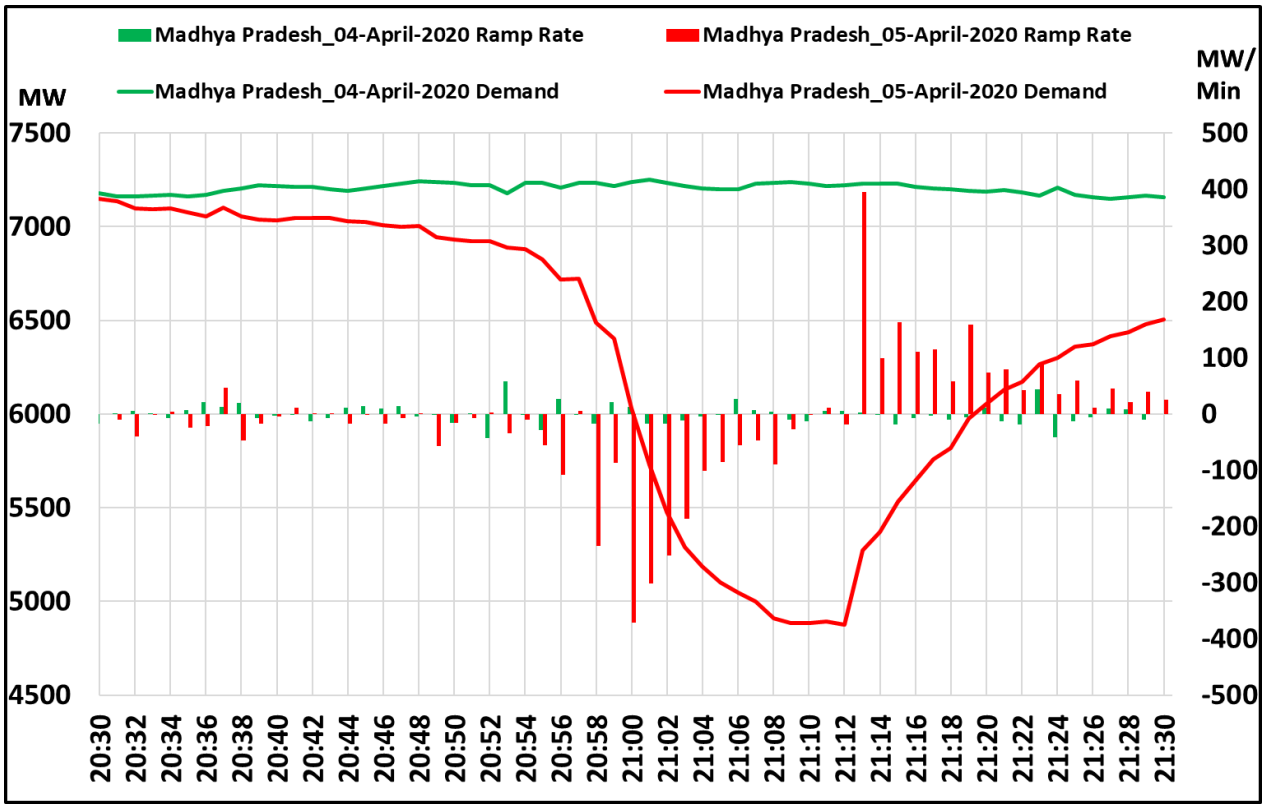
Madhya Pradesh_04-April-2020 Ramp Rate
Madhya Pradesh_05-April-2020 Ramp Rate
Madhya Pradesh_04-April-2020 Demand
Madhya Pradesh_05-April-2020 Demand
MW
MW/ Min
7500
7000
6500
6000
5500
5000
4500
500
400
300
200
100
0
-100
-200
-300
-400
-500
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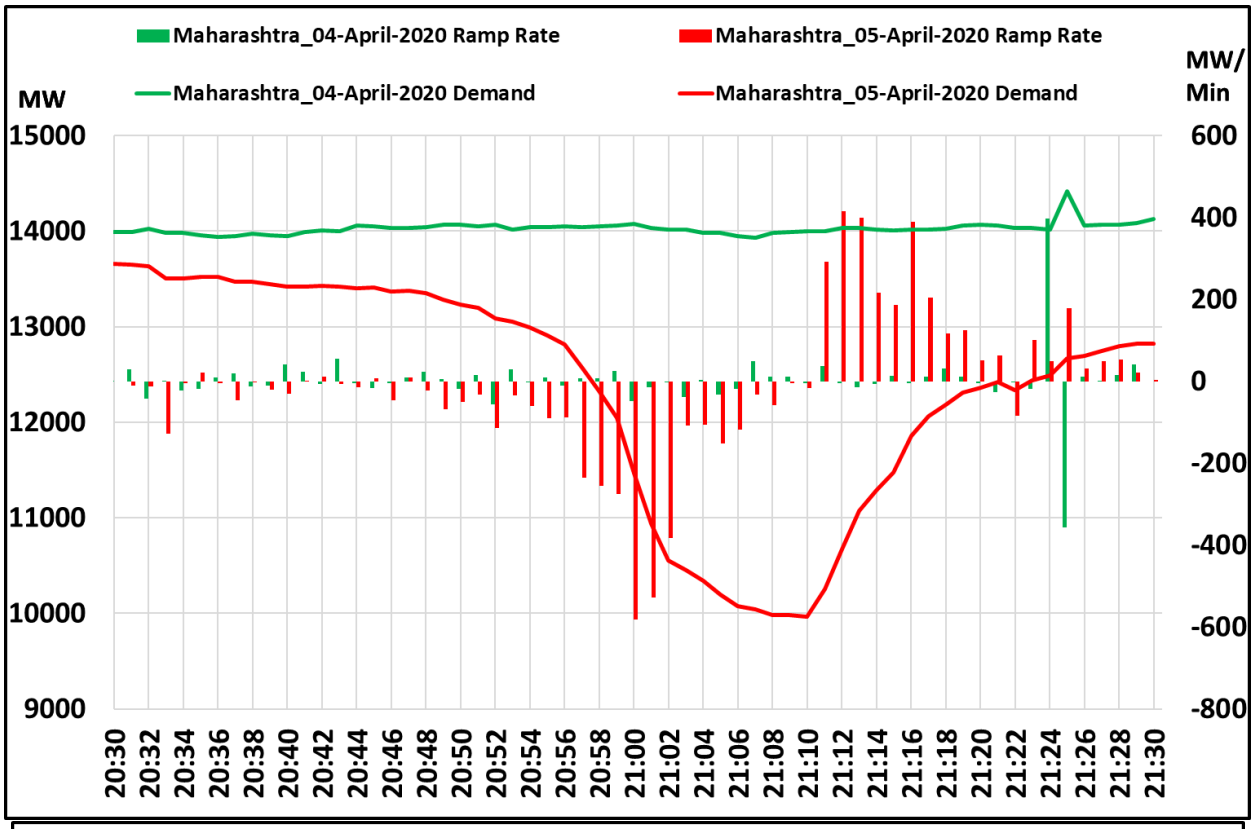
Maharashtra_04-April-2020 Ramp Rate
Maharashtra_05-April-2020 Ramp Rate
Maharashtra_04-April-2020 Demand
Maharashtra_05-April-2020 Demand
MW
MW/ Min
15000
14000
13000
12000
11000
10000
9000
600
400
200
0
-200
-400
-600
-800
20:30
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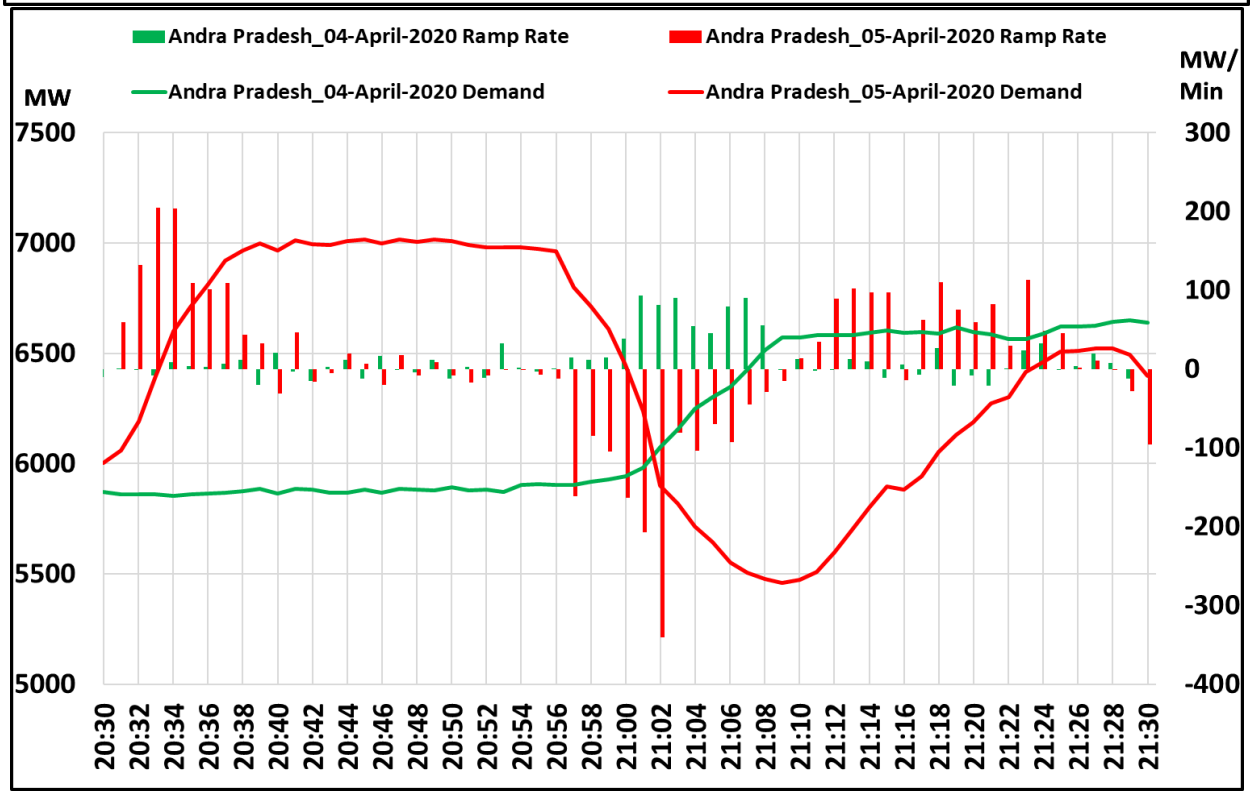
Andra Pradesh_04-April-2020 Ramp Rate
Andra Pradesh_05-April-2020 Ramp Rate
Andra Pradesh_04-April-2020 Demand
Andra Pradesh_05-April-2020 Demand
MW
MW/ Min
7500
7000
6500
6000
5500
5000
300
200
100
0
-100
-200
-300
-400
20:30
20:32
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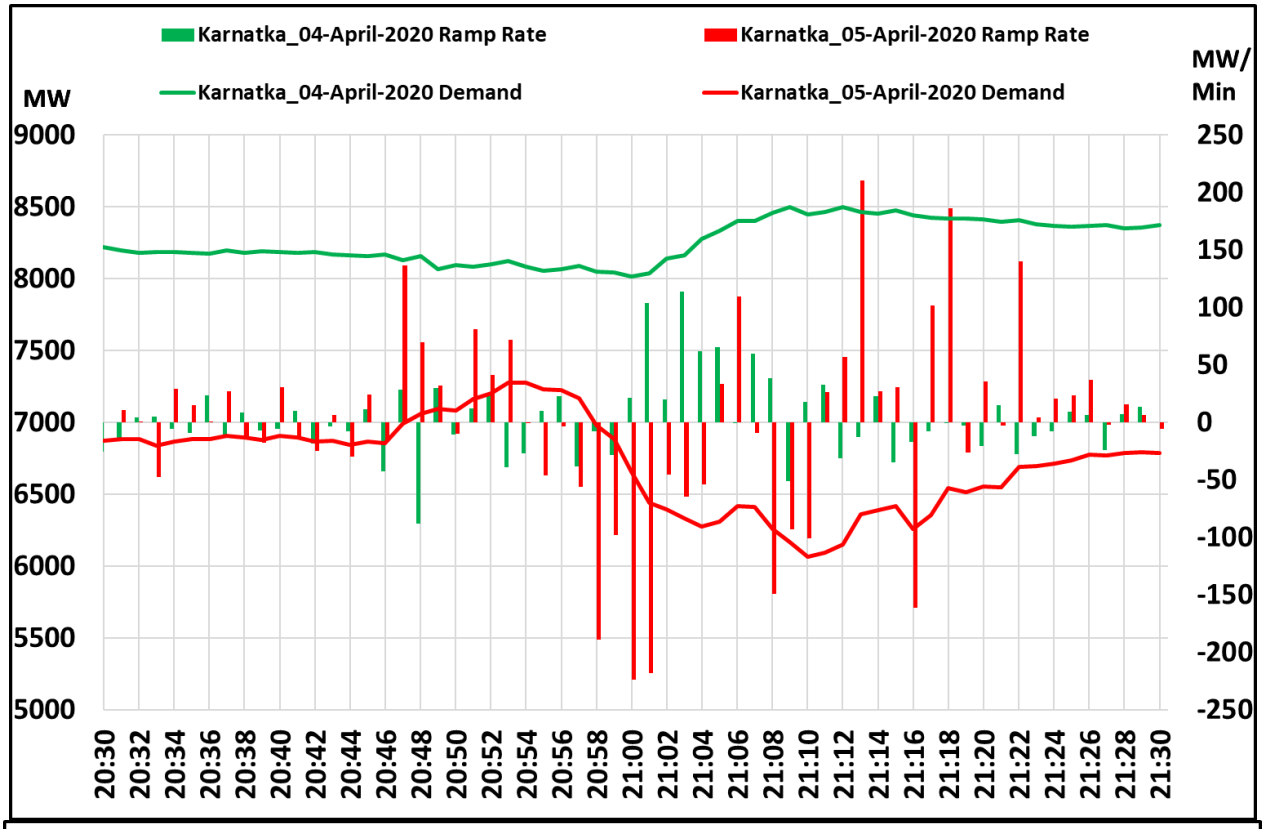
Karnatka_04-April-2020 Ramp Rate
Karnatka_05-April-2020 Ramp Rate
Karnatka_04-April-2020 Demand
Karnatka_05-April-2020 Demand
MW
MW/ Min
9000
8500
8000
7500
7000
6500
6000
5500
5000
250
200
150
100
50
0
-50
-100
-150
-200
-250
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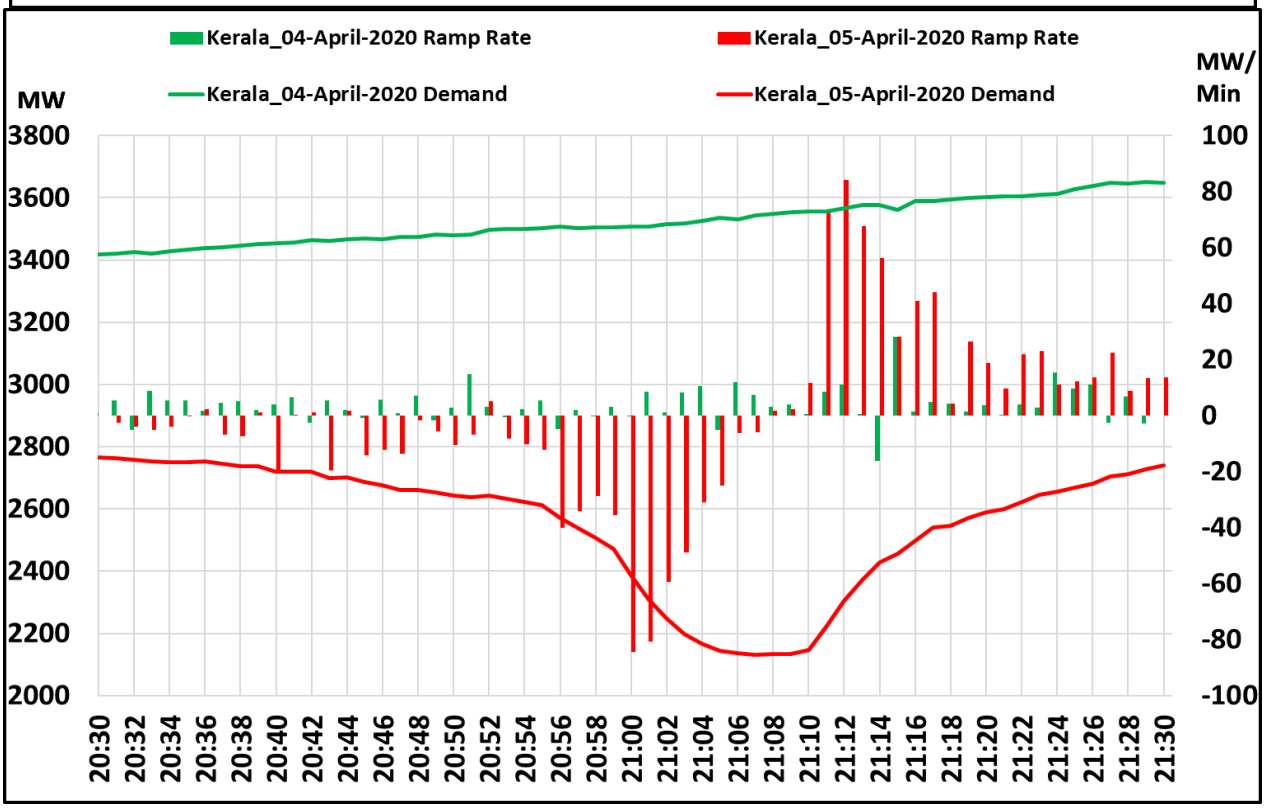
Kerala_04-April-2020 Ramp Rate
Kerala_05-April-2020 Ramp Rate
Kerala_04-April-2020 Demand
Kerala_05-April-2020 Demand
MW
MW/ Min
3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
100
80
60
40
20
0
-20
-40
-60
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-100
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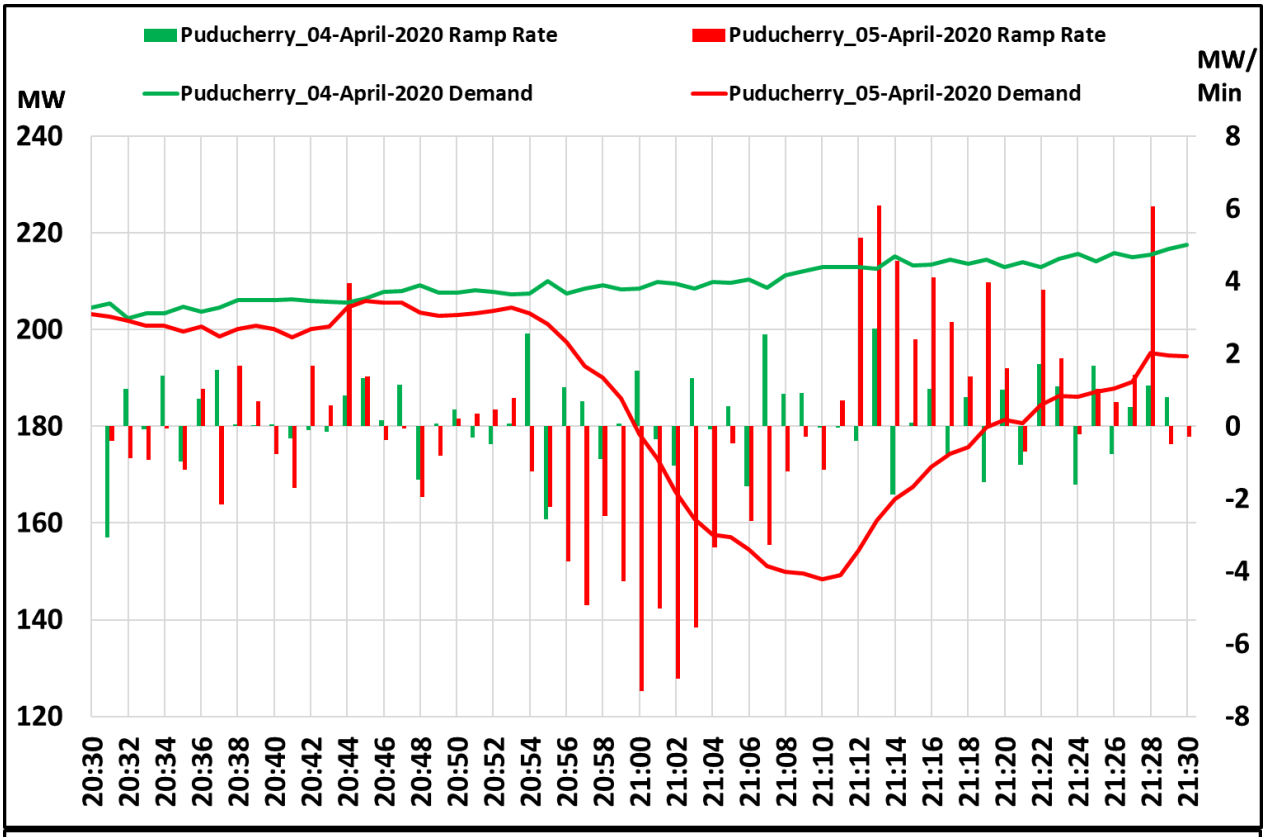
Puducherry_04-April-2020 Ramp Rate
Puducherry_05-April-2020 Ramp Rate
Puducherry_04-April-2020 Demand
Puducherry_05-April-2020 Demand
MW
MW/ Min
240
220
200
180
160
140
120
8
6
4
2
0
-2
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-6
-8
20:30
20:32
20:34
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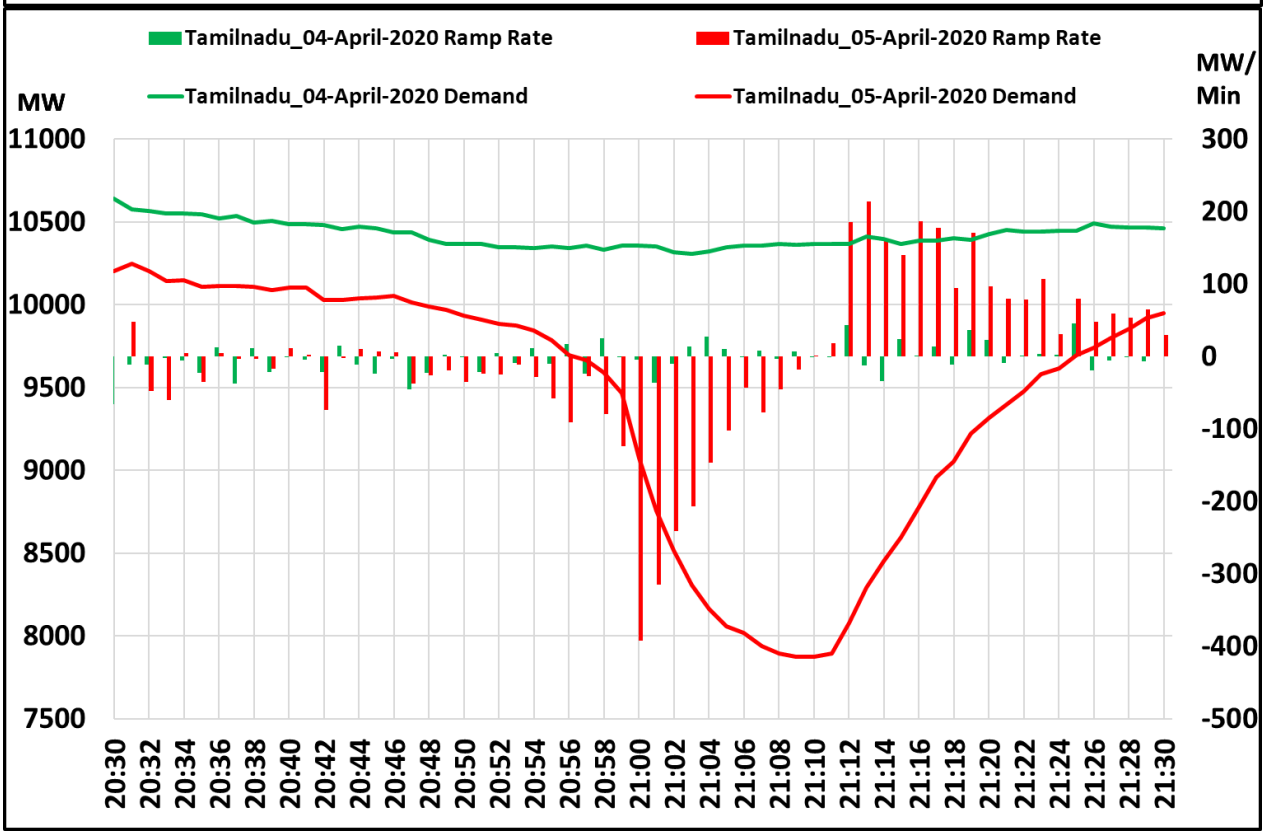
Tamilnadu_04-April-2020 Ramp Rate
Tamilnadu_05-April-2020 Ramp Rate
Tamilnadu_04-April-2020 Demand
Tamilnadu_05-April-2020 Demand
MW
MW/ Min
11000
10500
10000
9500
9000
8500
8000
7500
300
200
100
0
-100
-200
-300
-400
-500
20:30
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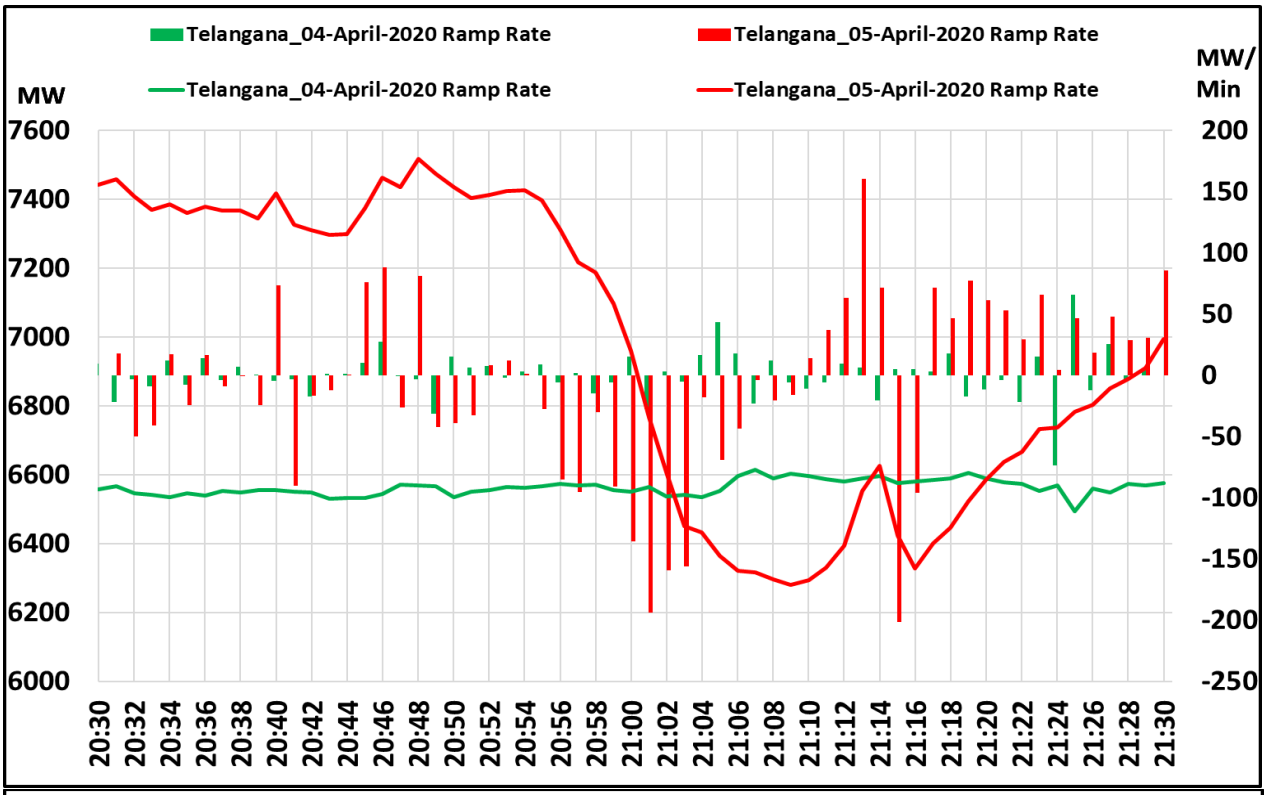
Telangana_04-April-2020 Ramp Rate
Telangana_05-April-2020 Ramp Rate
Telangana_04-April-2020 Ramp Rate
Telangana_05-April-2020 Ramp Rate
MW
MW/ Min
7600
7400
7200
7000
6800
6600
6400
6200
6000
200
150
100
50
0
-50
-100
-150
-200
-250
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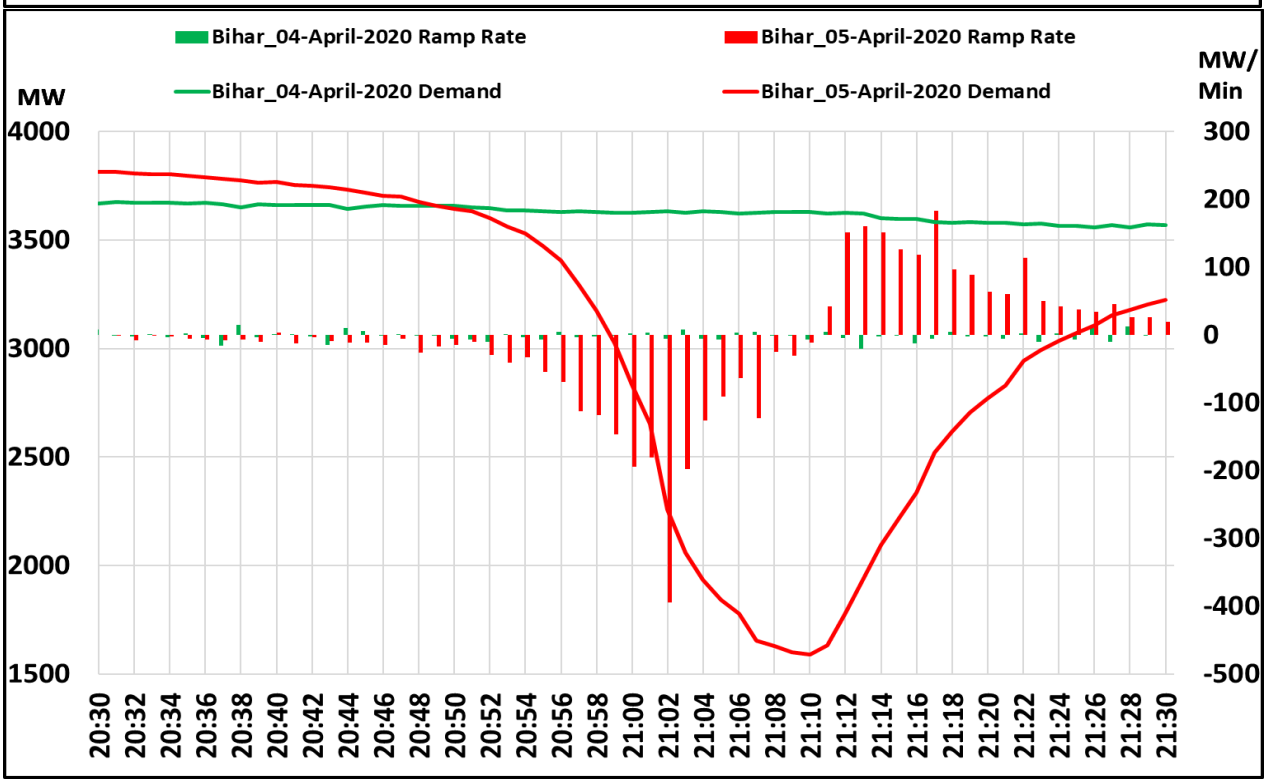
Bihar_04-April-2020 Ramp Rate
Bihar_05-April-2020 Ramp Rate
Bihar_04-April-2020 Demand
Bihar_05-April-2020 Demand
MW
MW/ Min
4000
3500
3000
2500
2000
1500
300
200
100
0
-100
-200
-300
-400
-500
20:30
20:32
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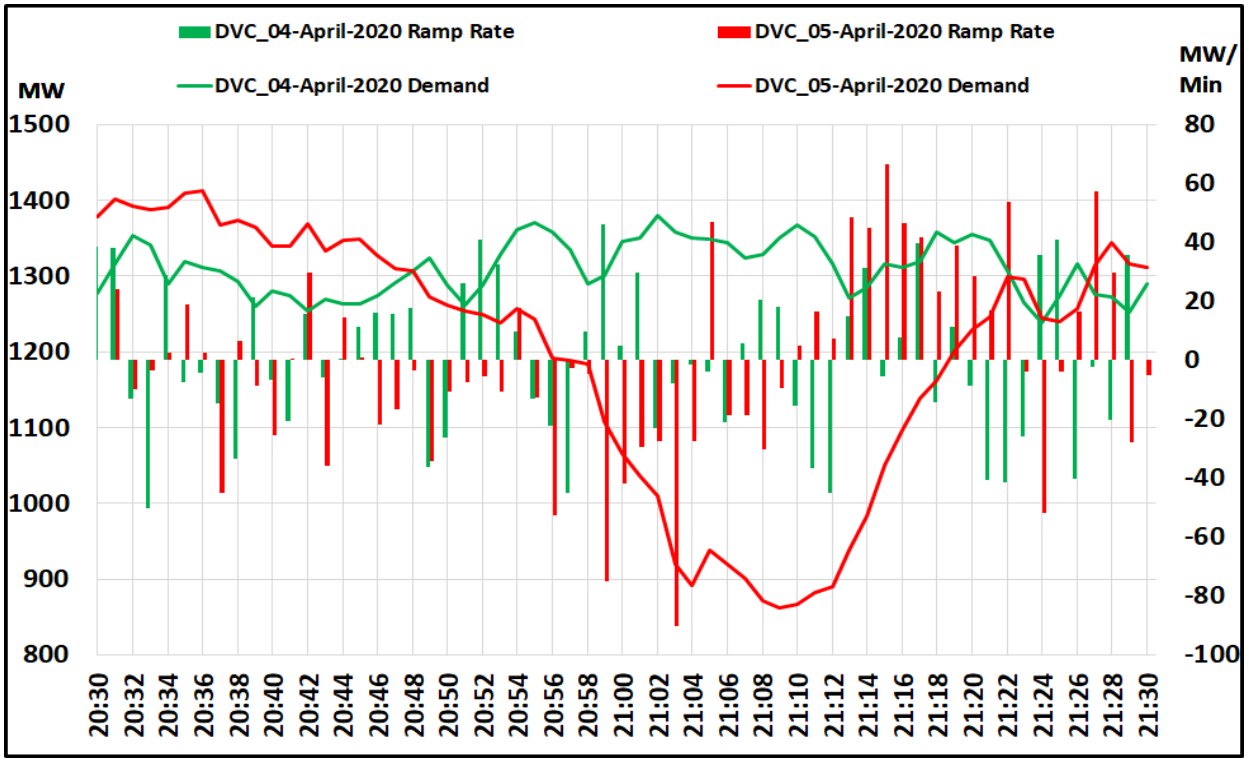
DVC_04-April-2020 Ramp Rate
DVC_05-April-2020 Ramp Rate
DVC_04-April-2020 Demand
DVC_05-April-2020 Demand
MW
MW/ Min
1500
1400
1300
1200
1100
1000
900
800
80
60
40
20
0
-20
-40
-60
-80
-100
20:30
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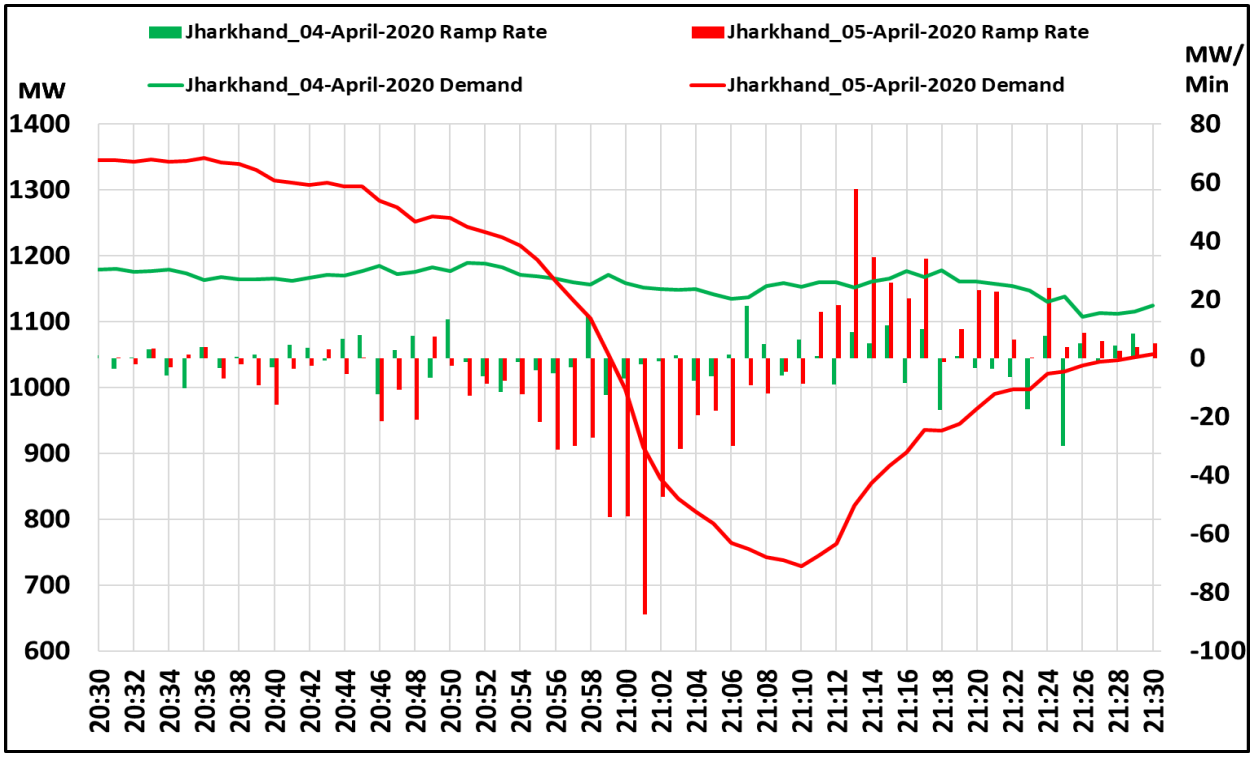
Jharkhand_04-April-2020 Ramp Rate
Jharkhand_05-April-2020 Ramp Rate
Jharkhand_04-April-2020 Demand
Jharkhand_05-April-2020 Demand
MW
MW/ Min
1400
1300
1200
1100
1000
900
800
700
600
80
60
40
20
0
-20
-40
-60
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-100
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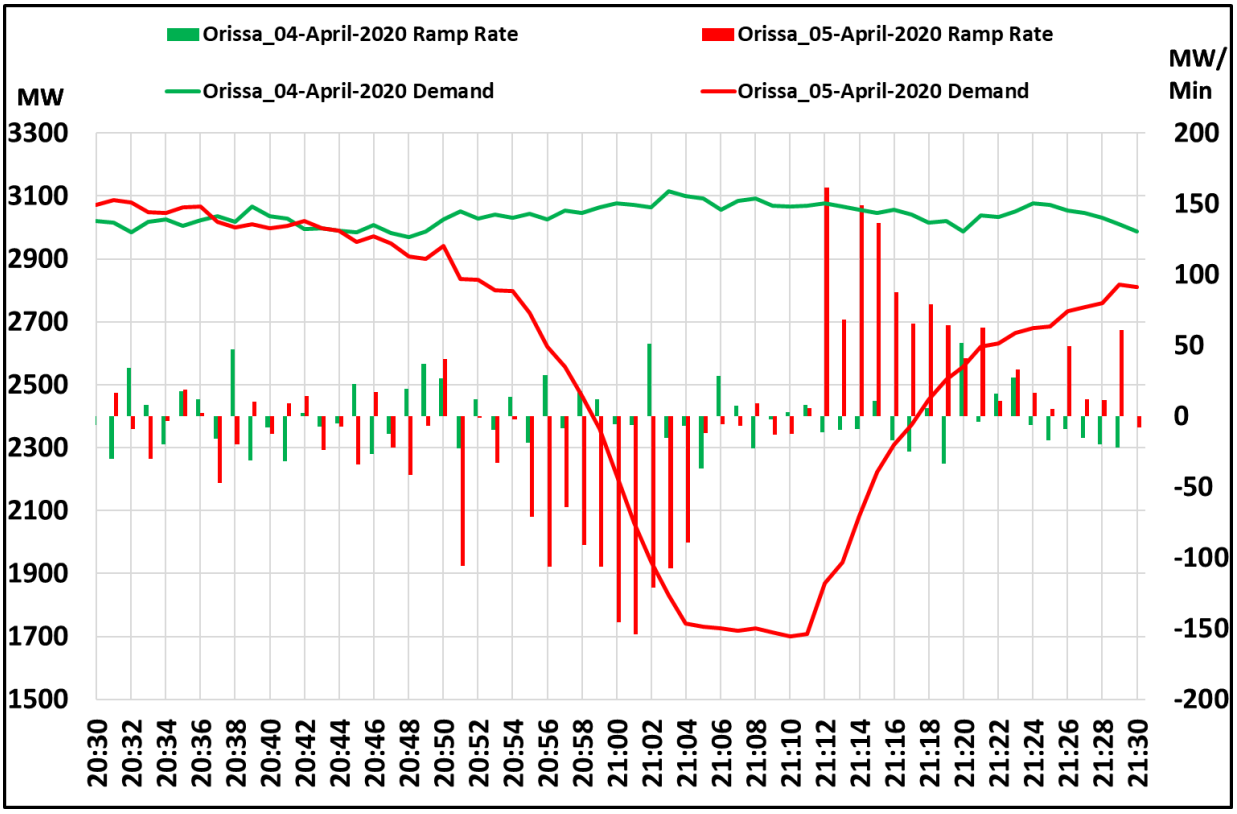
Orissa_04-April-2020 Ramp Rate
Orissa_05-April-2020 Ramp Rate
Orissa_04-April-2020 Demand
Orissa_05-April-2020 Demand
MW
MW/ Min
3300
3100
2900
2700
2500
2300
2100
1900
1700
1500
200
150
100
50
0
-50
-100
-150
-200
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20:32
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20:38
20:40
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20:48
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20:54
20:56
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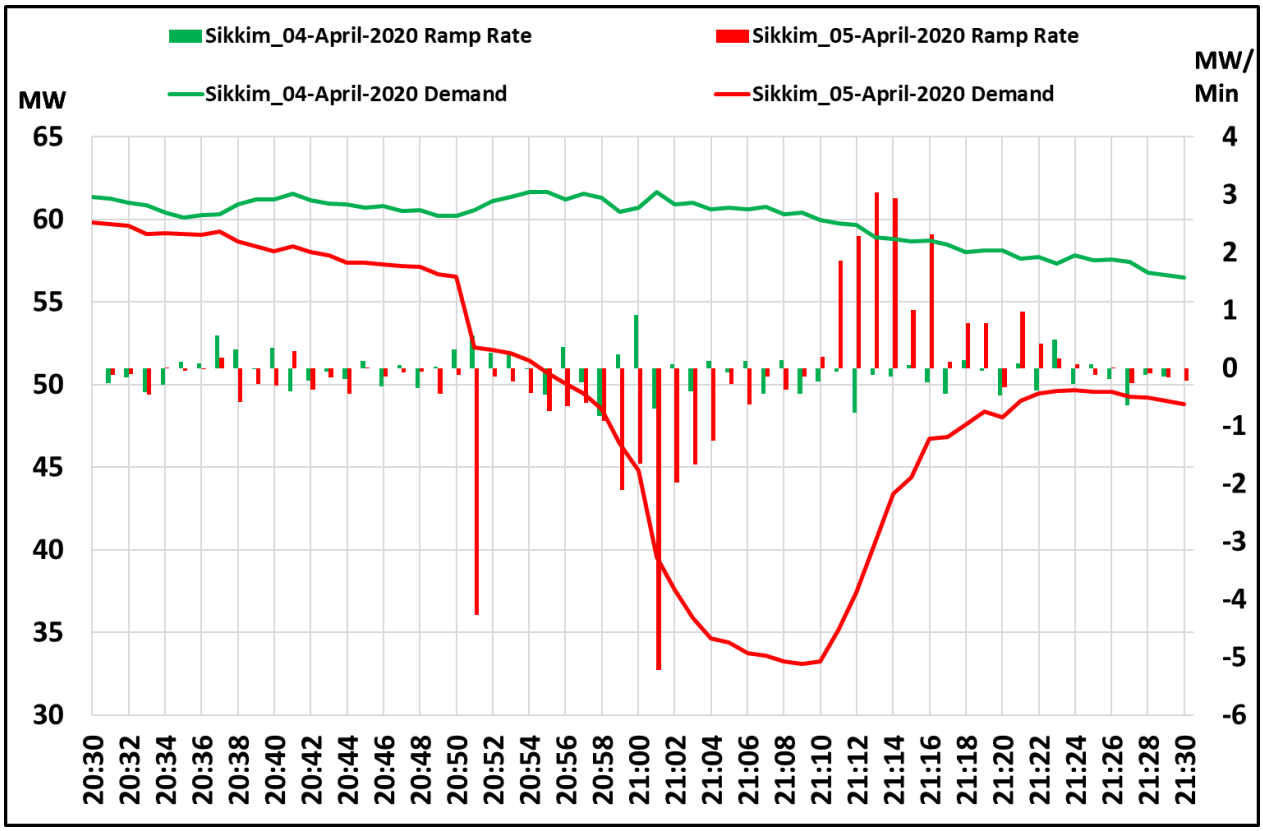
Sikkim_04-April-2020 Ramp Rate
Sikkim_05-April-2020 Ramp Rate
Sikkim_04-April-2020 Demand
Sikkim_05-April-2020 Demand
MW
MW/ Min
65
60
55
50
45
40
35
30
4
3
2
1
0
-1
-2
-3
-4
-5
-6
20:30
20:32
20:34
20:36
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20:42
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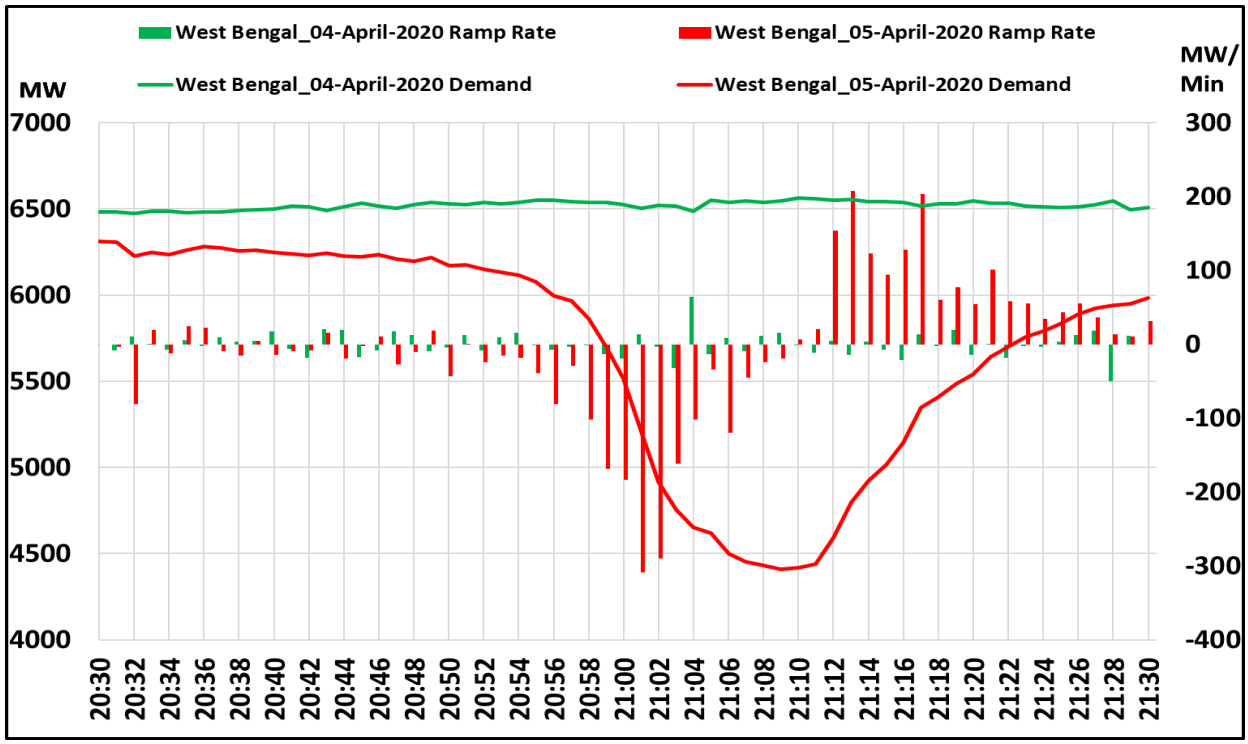
West Bengal_04-April-2020 Ramp Rate
West Bengal_05-April-2020 Ramp Rate
West Bengal_04-April-2020 Demand
West Bengal_05-April-2020 Demand
MW
MW/ Min
7000
6500
6000
5500
5000
4500
4000
300
200
100
0
-100
-200
-300
-400
20:30
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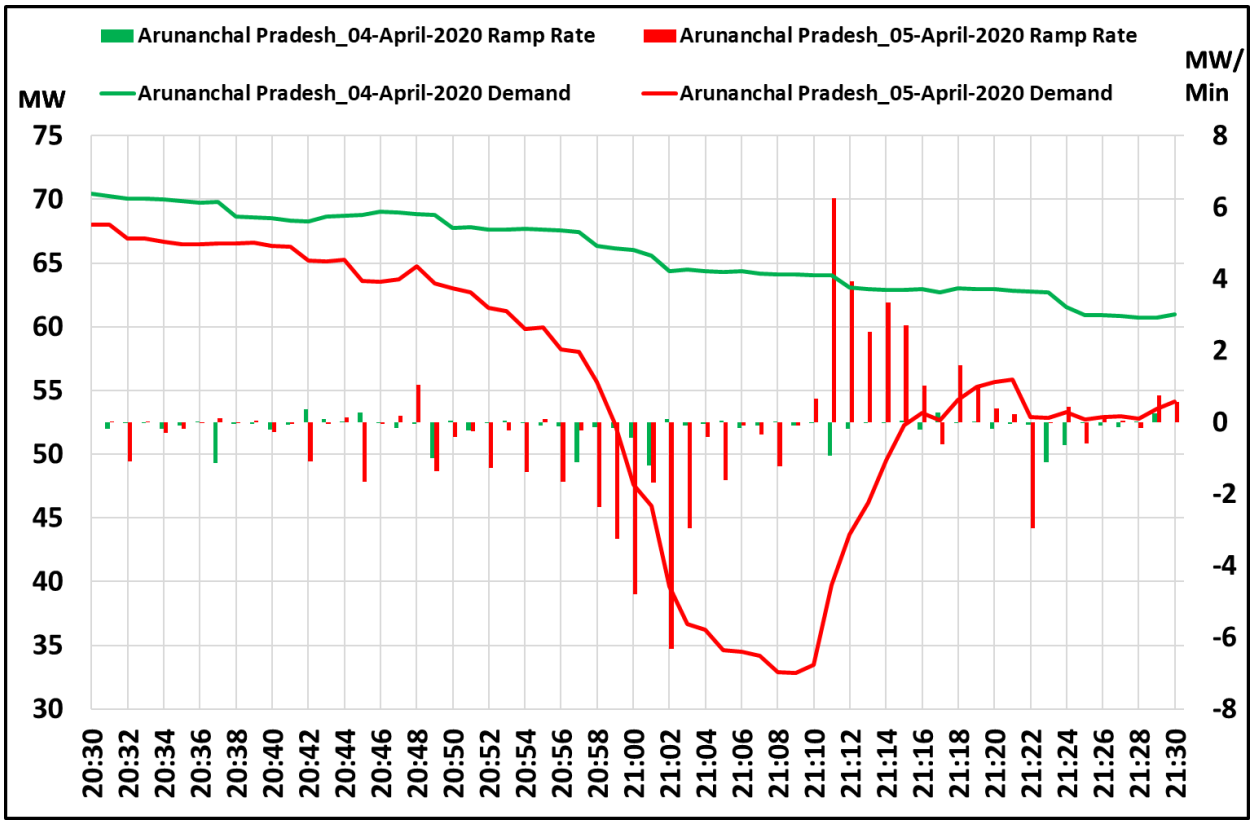
Arunanchal Pradesh_04-April-2020 Ramp Rate
Arunanchal Pradesh_05-April-2020 Ramp Rate
Arunanchal Pradesh_04-April-2020 Demand
Arunanchal Pradesh_05-April-2020 Demand
MW
MW/ Min
75
70
65
60
55
50
45
40
35
30
8
6
4
2
0
-2
-4
-6
-8
20:30
20:32
20:34
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20:40
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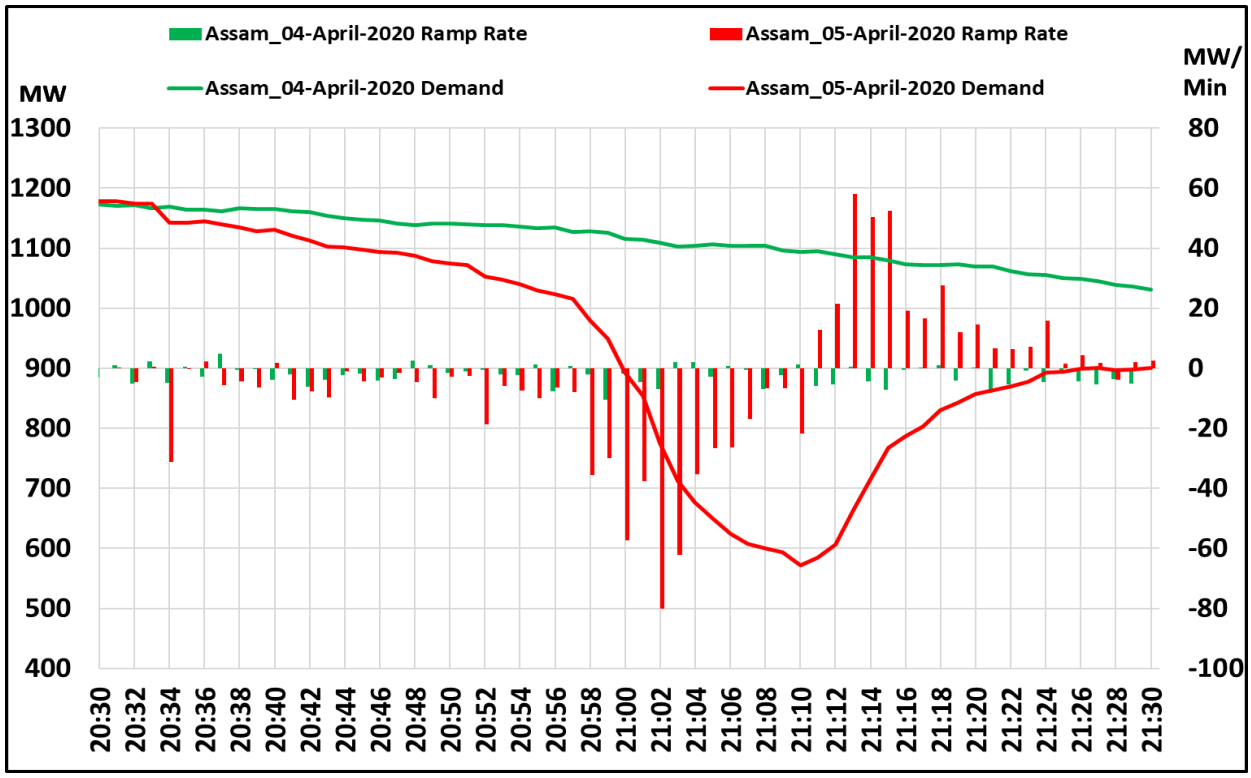
Assam_04-April-2020 Ramp Rate
Assam_05-April-2020 Ramp Rate
Assam_04-April-2020 Demand
Assam_05-April-2020 Demand
MW
MW/ Min
1300
1200
1100
1000
900
800
700
600
500
400
80
60
40
20
0
-20
-40
-60
-80
-100
20:30
20:32
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20:52
20:54
20:56
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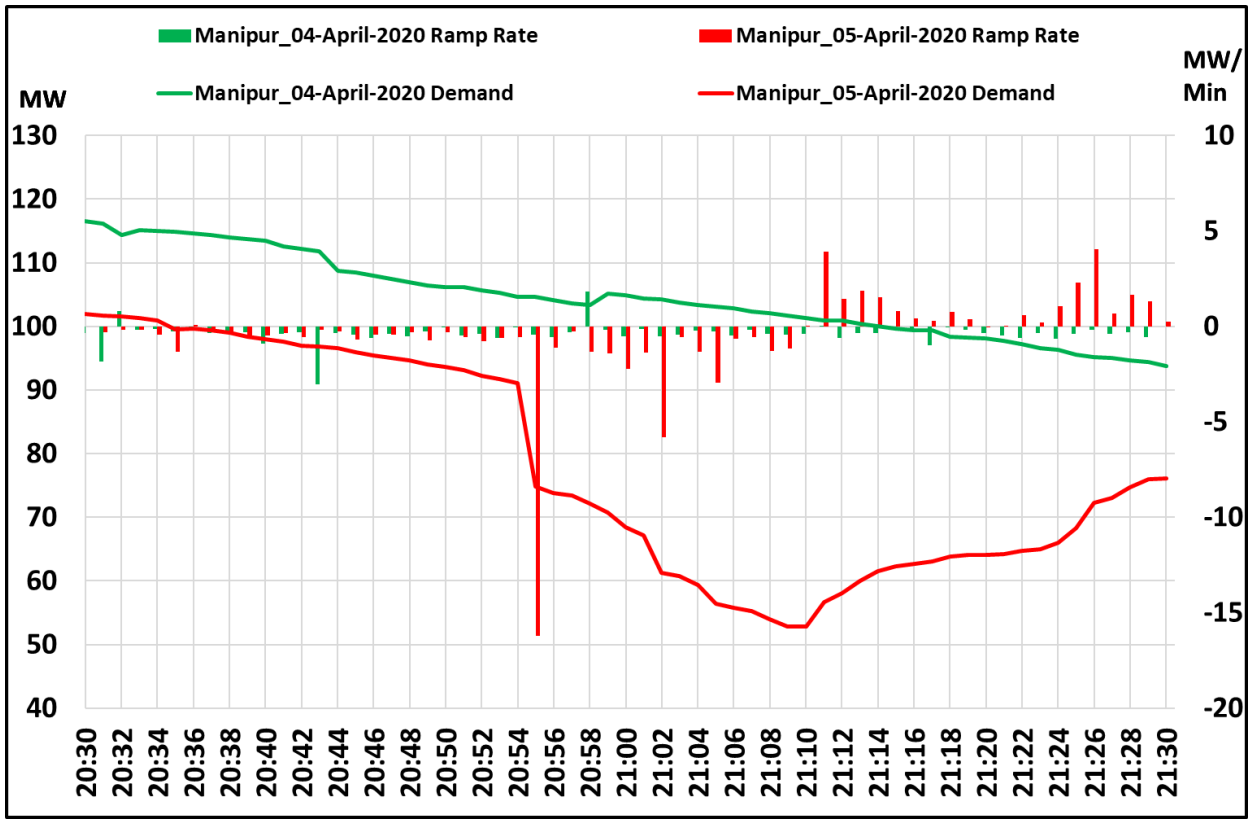
Manipur_04-April-2020 Ramp Rate
Manipur_05-April-2020 Ramp Rate
Manipur_04-April-2020 Demand
Manipur_05-April-2020 Demand
MW
MW/ Min
130
120
110
100
90
80
70
60
50
40
10
5
0
-5
-10
-15
-20
20:30
20:32
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20:56
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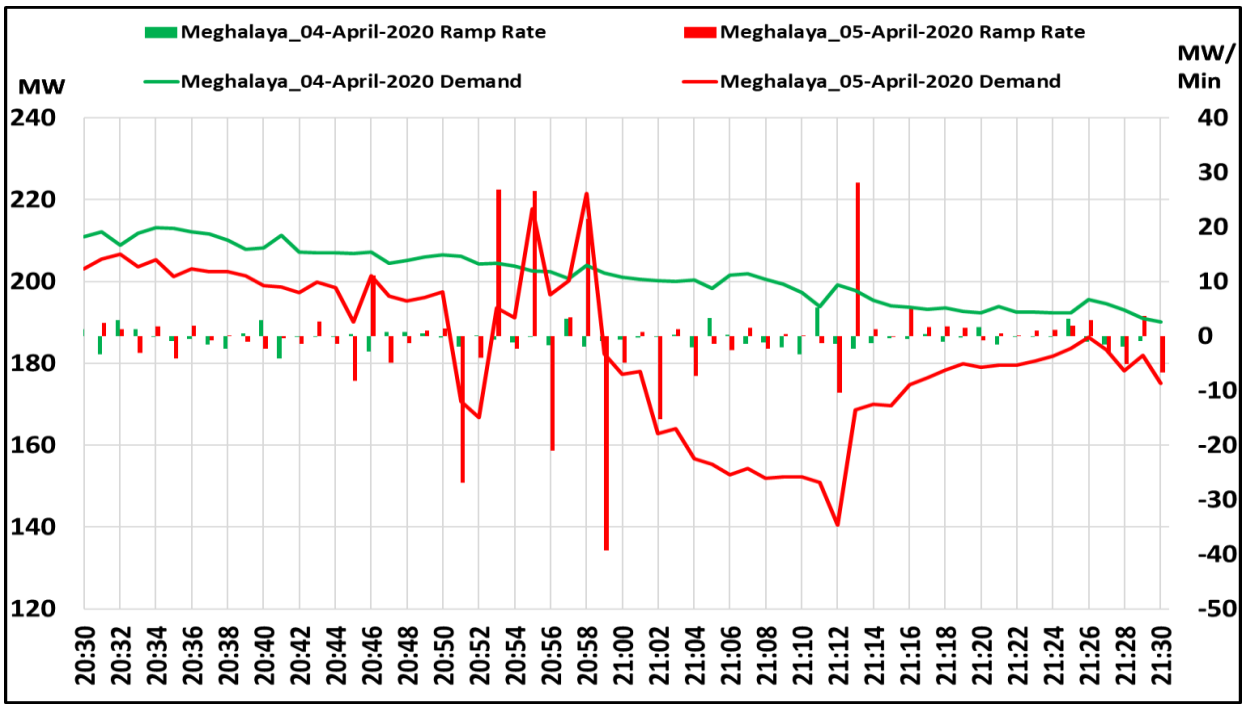
Meghalaya_04-April-2020 Ramp Rate
Meghalaya_05-April-2020 Ramp Rate
Meghalaya_04-April-2020 Demand
Meghalaya_05-April-2020 Demand
MW
MW/ Min
240
220
200
180
160
140
120
40
30
20
10
0
-10
-20
-30
-40
-50
20:30
20:32
20:34
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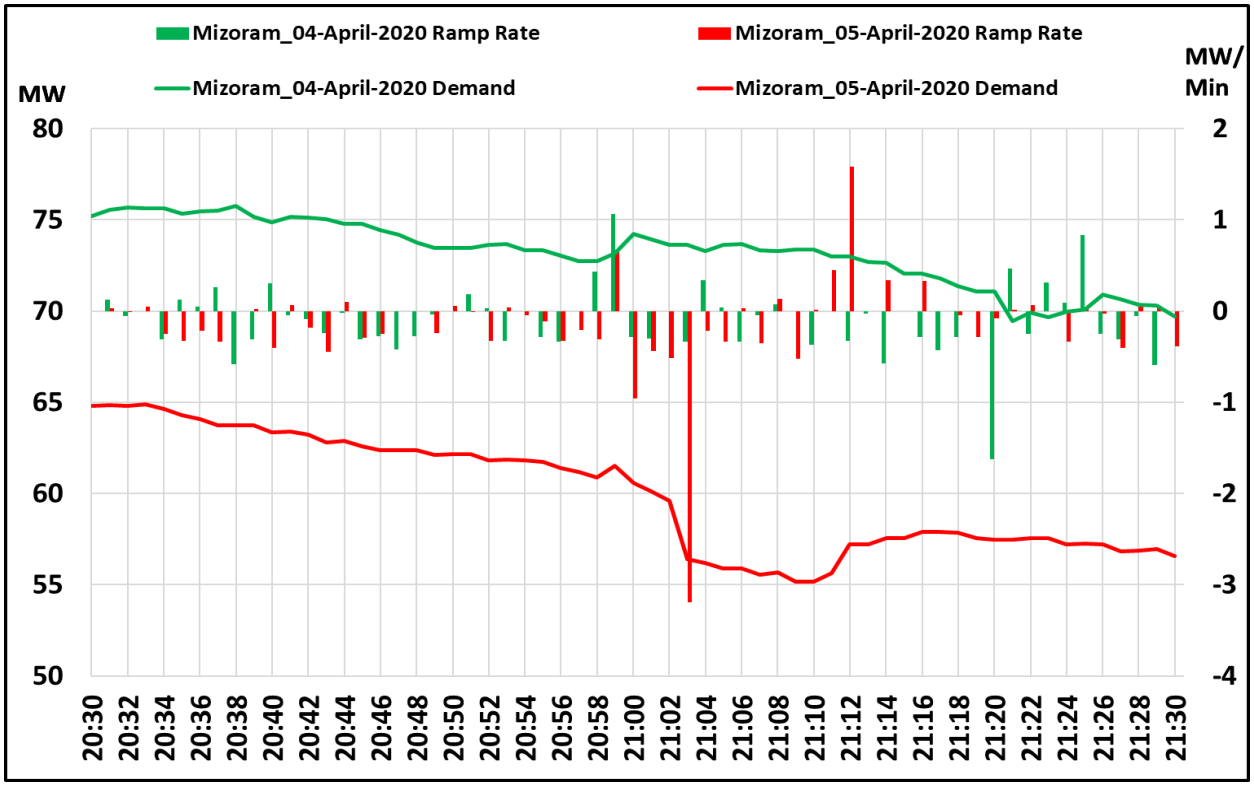
Mizoram_04-April-2020 Ramp Rate
Mizoram_05-April-2020 Ramp Rate
Mizoram_04-April-2020 Demand
Mizoram_05-April-2020 Demand
MW
MW/ Min
80
75
70
65
60
55
50
2
1
0
-1
-2
-3
-4
20:30
20:32
20:34
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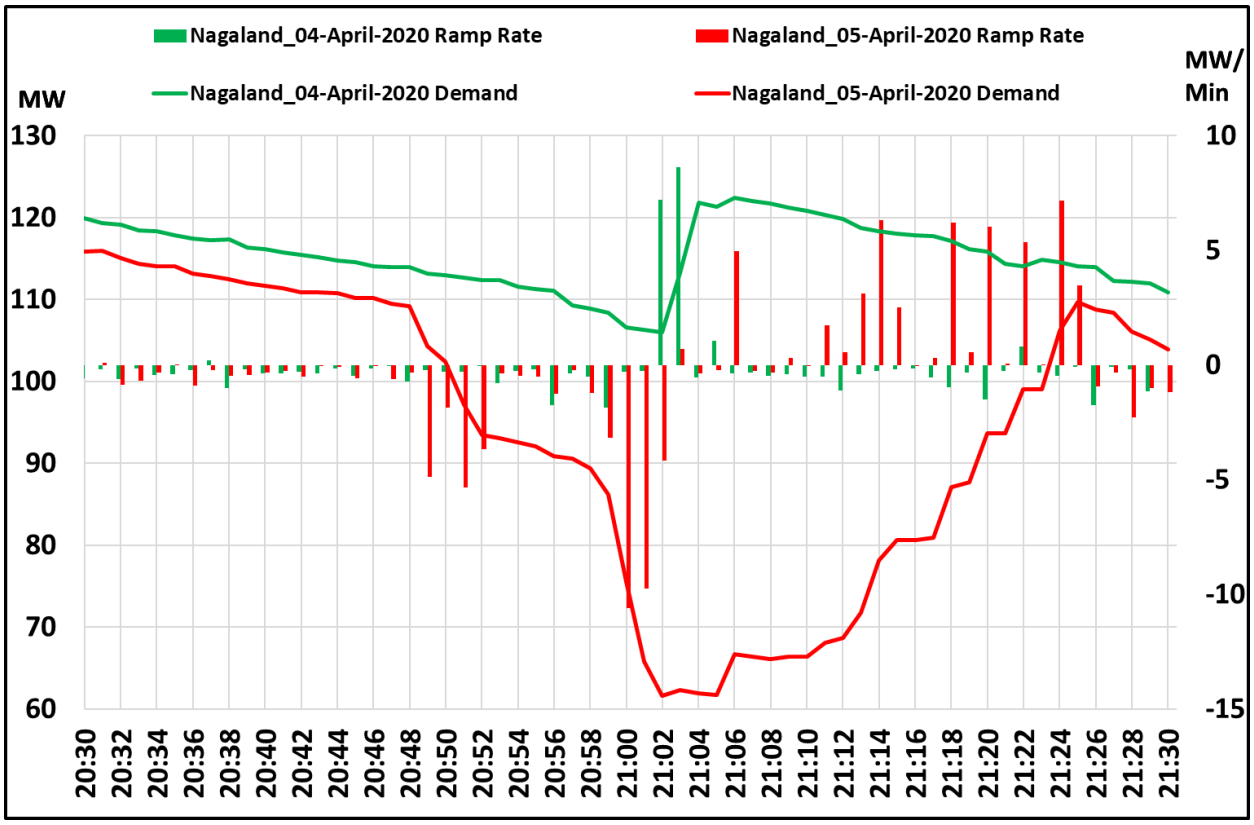
Nagaland_04-April-2020 Ramp Rate
Nagaland_05-April-2020 Ramp Rate
Nagaland_04-April-2020 Demand
Nagaland_05-April-2020 Demand
MW
MW/ Min
130
120
110
100
90
80
70
60
10
5
0
-5
-10
-15
20:30
20:32
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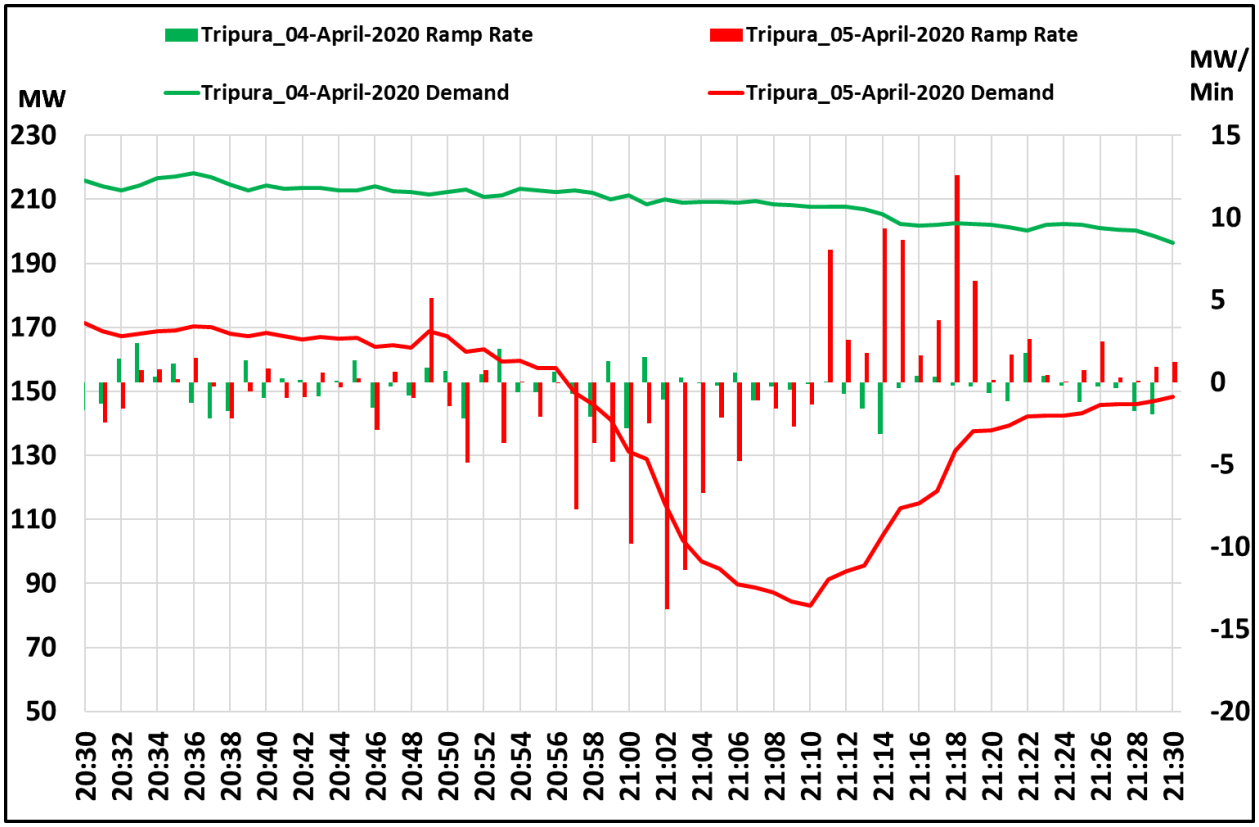
Tripura_04-April-2020 Ramp Rate
Tripura_05-April-2020 Ramp Rate
Tripura_04-April-2020 Demand
Tripura_05-April-2020 Demand
MW
MW/ Min
230
210
190
170
150
130
110
90
70
50
15
10
5
0
-5
-10
-15
-20
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
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20:50
20:52
20:54
20:56
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21:00
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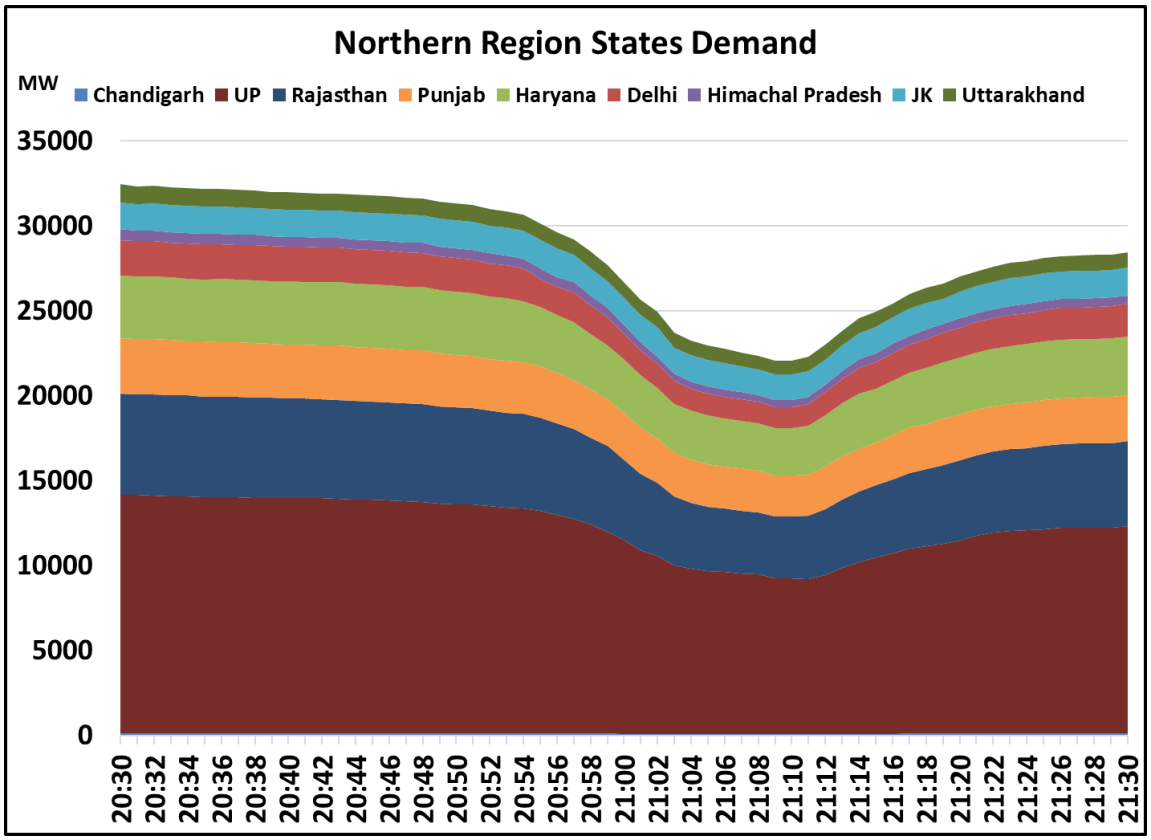
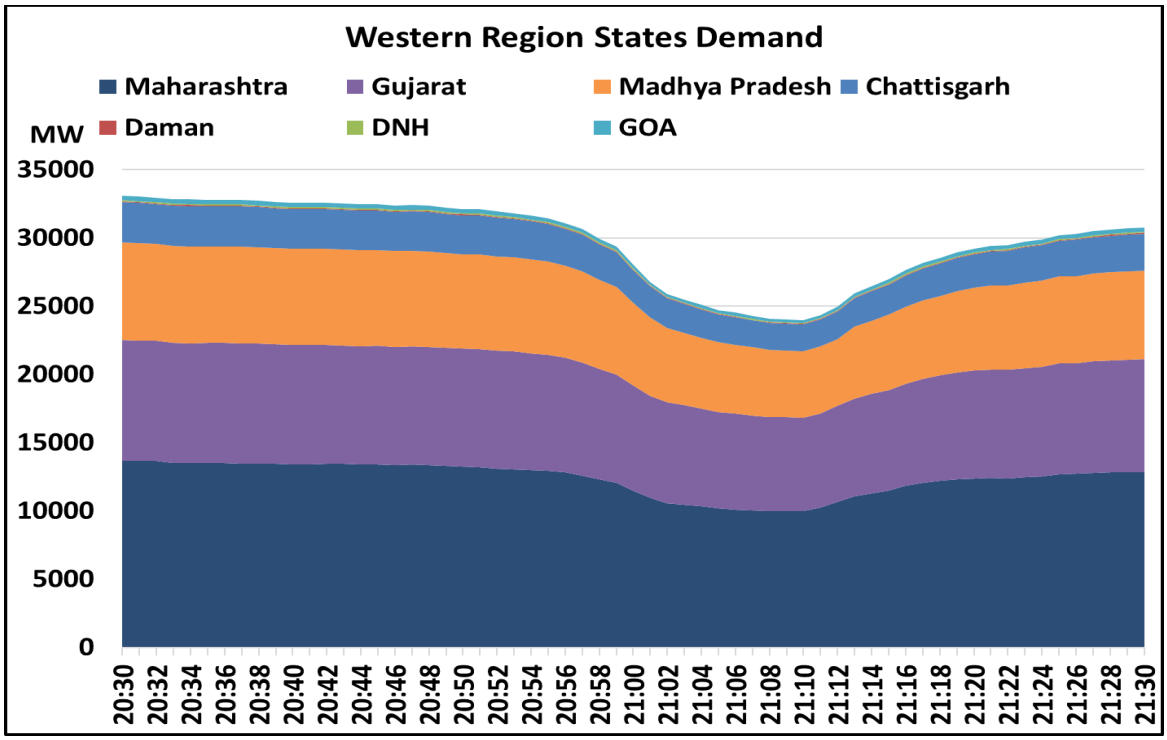
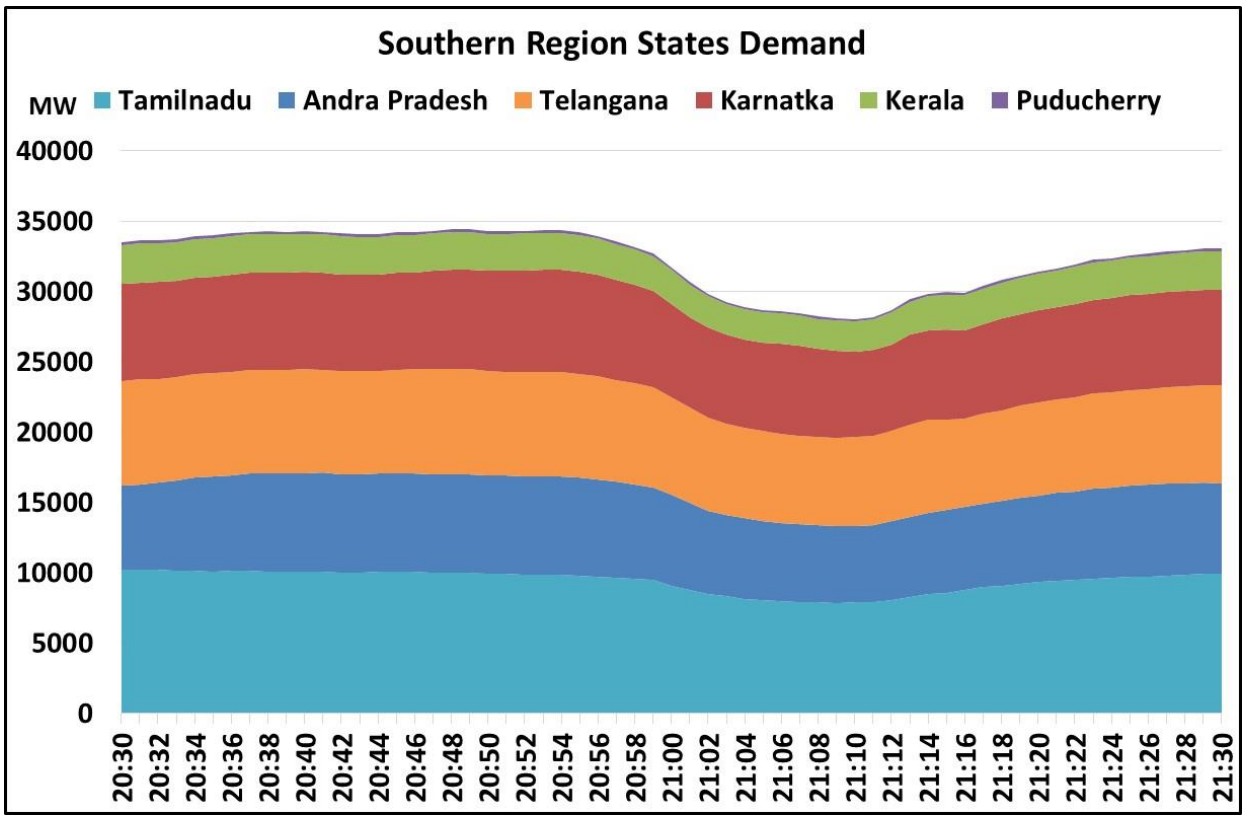
5.1.2 Stack Plots of State Demands






Southern Region States Demand
MW
Tamilnadu
Andra Pradesh
Telangana
Karnatka
Kerala
Puducherry
40000
35000
30000
25000
20000
15000
10000
5000
0
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
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21:18
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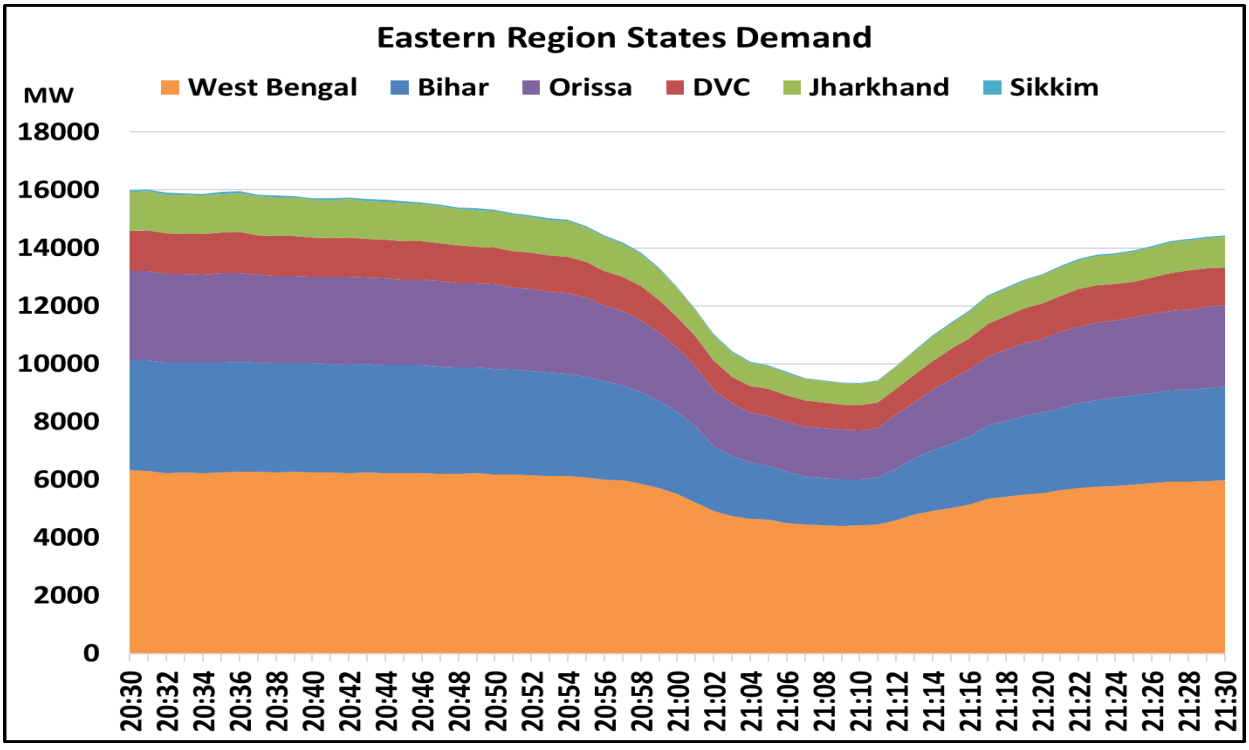
21:28
21:30


Eastern Region States Demand
MW
West Bengal
Bihar
Orissa
DVC
Jharkhand
Sikkim
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
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21:16
21:18
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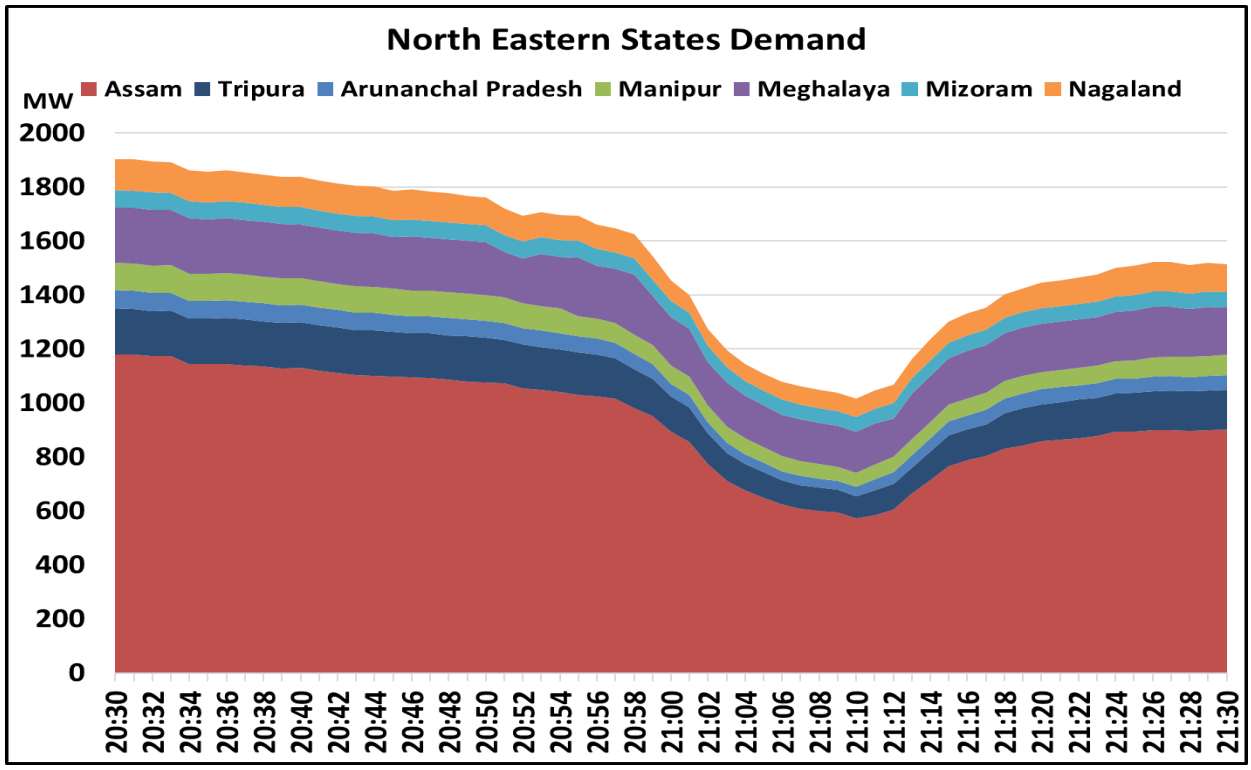
21:22
21:24
21:26
21:28
21:30


North Eastern States Demand
Assam
Tripura
Arunanchal Pradesh
Manipur
Meghalaya
Mizoram
Nagaland
MW
2000
1800
1600
1400
1200
1000
800
600
400
200
0
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
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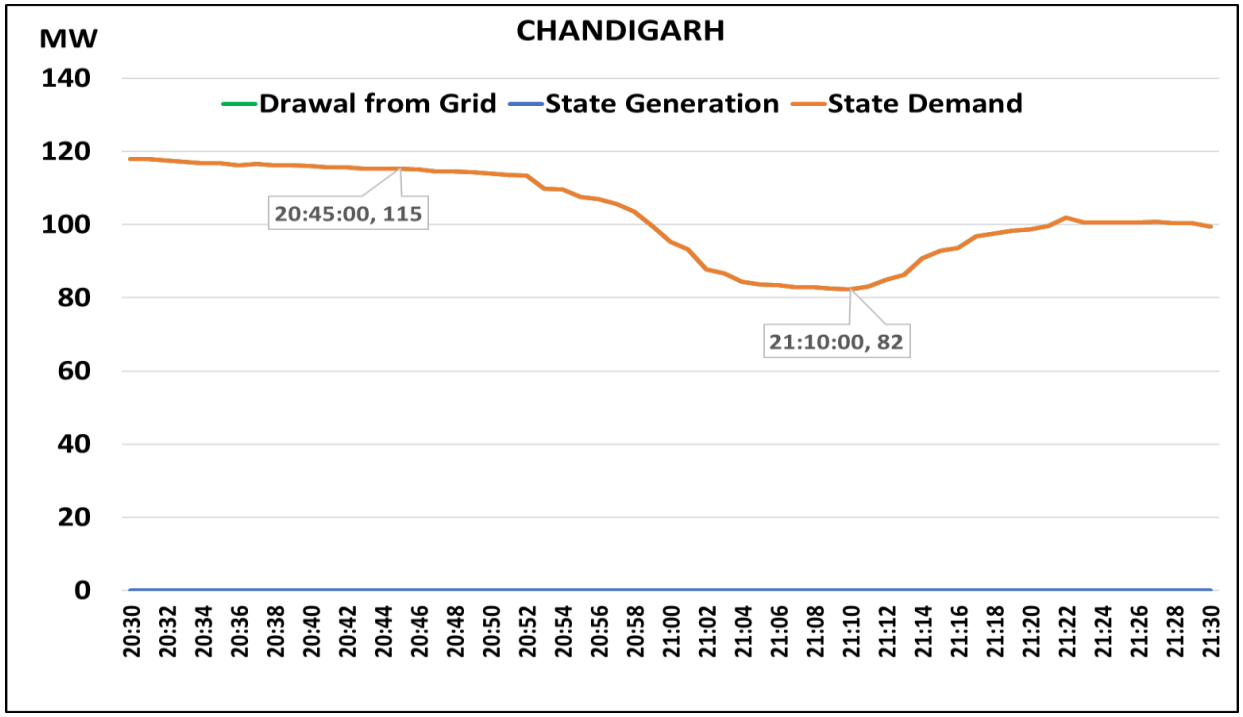
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

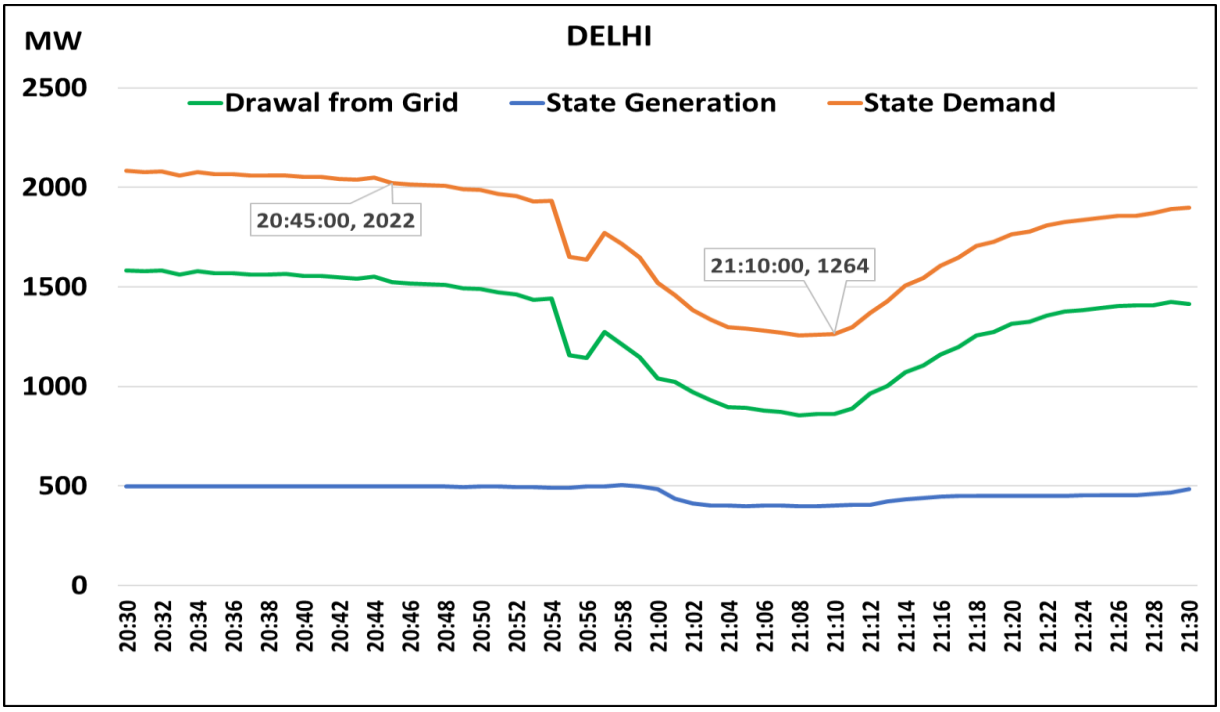
Annexure 5.2 Minute Wise Data of all India and Regional Demands

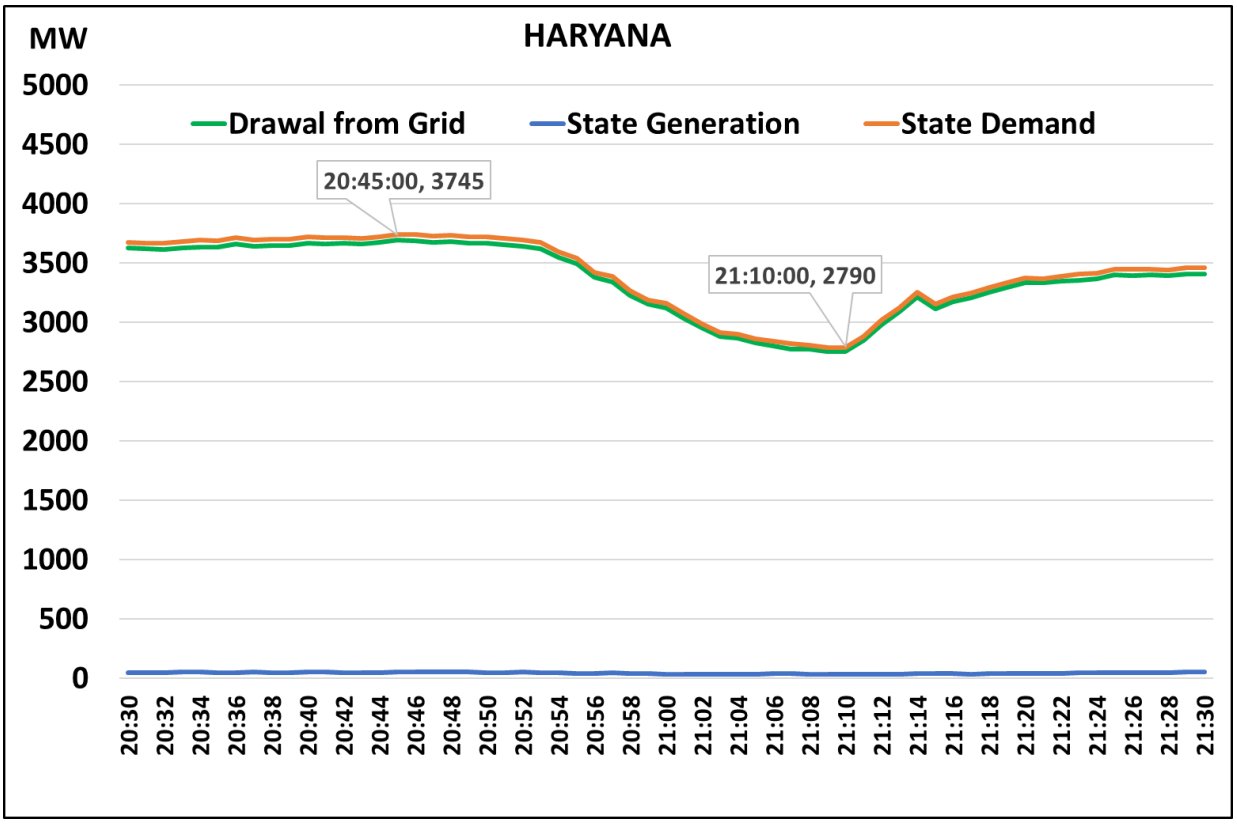
Demand Met (MW) – 5th Apr 2020						
Time (hrs)	**NR**	**WR**	**SR**	**ER**	**NER**	**All India**
20:30	32438	33122	34010	16324	1903	**117797**
20:31	32336	33013	34176	16468	1903	**117896**
20:32	32366	32971	34221	16213	1896	**117666**
20:33	32287	32841	34310	16255	1893	**117586**
20:34	32220	32819	34567	16230	1863	**117700**
20:35	32181	32822	34698	16226	1857	**117785**
20:36	32172	32805	34844	16215	1862	**117898**
20:37	32118	32778	34931	16078	1854	**117758**
20:38	32071	32718	34964	16063	1847	**117663**
20:39	31995	32633	34918	16069	1838	**117454**
20:40	31976	32636	34949	15905	1837	**117303**
20:41	31951	32588	34935	15866	1825	**117165**
20:42	31907	32568	34838	15937	1812	**117063**
20:43	31905	32537	34807	15885	1805	**116938**
20:44	31828	32481	34970	15879	1802	**116959**
20:45	31791	32474	35012	15815	1796	**116887**
20:46	31755	32391	35048	15881	1790	**116864**
20:47	31659	32408	35200	15663	1784	**116714**
20:48	31628	32353	35296	15515	1777	**116569**
20:49	31423	32219	35269	15484	1766	**116162**
20:50	31339	32113	35109	15452	1761	**115775**
20:51	31232	32115	35147	15268	1720	**115482**
20:52	31001	31987	35130	15340	1692	**115150**
20:53	30872	31834	35120	15184	1708	**114718**
20:54	30673	31656	35111	15150	1696	**114286**
20:55	30148	31462	35019	14928	1693	**113251**
20:56	29632	31078	34741	14666	1661	**111778**
20:57	29203	30670	34408	14404	1648	**110333**
20:58	28509	29938	34082	13919	1625	**108073**
20:59	27699	29356	33669	13364	1544	**105632**
21:00	26683	28091	32688	12752	1453	**101667**
21:01	25665	26794	31552	12060	1400	**97471**
21:02	24921	26044	30655	11139	1274	**94034**
21:03	23695	25544	30075	10578	1196	**91088**
21:04	23242	25114	29886	10258	1144	**89644**
21:05	22939	24733	29736	10214	1109	**88731**
21:06	22743	24533	29555	9970	1079	**87880**
21:07	22535	24299	29431	9878	1061	**87206**

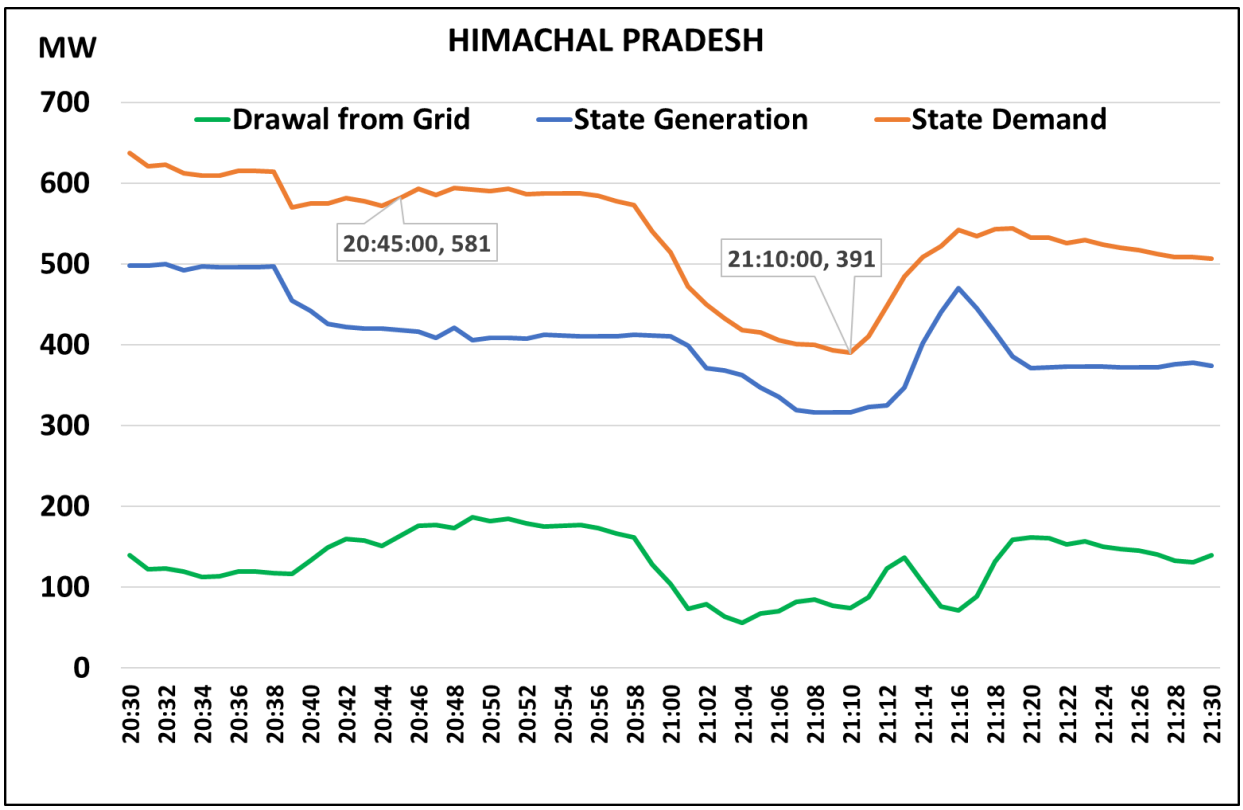
Demand Met (MW) – 5th Apr 2020						
Time (hrs)	**NR**	**WR**	**SR**	**ER**	**NER**	**All India**
21:08	22336	24106	29234	9833	1048	**86557**
21:09	22045	24045	29074	9699	1038	**85901**
21:10	22061	24010	29034	9679	1015	**85799**
21:11	22275	24368	29159	9780	1047	**86629**
21:12	22986	24904	29632	10232	1068	**88821**
21:13	23821	25967	30159	10727	1163	**91837**
21:14	24539	26483	30497	11214	1236	**93970**
21:15	24956	26992	30665	11879	1303	**95795**
21:16	25427	27681	30769	12311	1331	**97518**
21:17	25966	28193	31078	12491	1353	**99081**
21:18	26339	28542	31516	12824	1403	**100625**
21:19	26589	28951	31711	13100	1424	**101775**
21:20	27028	29229	31919	13411	1445	**103033**
21:21	27324	29432	32116	13799	1454	**104125**
21:22	27596	29505	32426	13971	1466	**104965**
21:23	27804	29684	32606	13983	1475	**105553**
21:24	27926	29900	32710	14053	1500	**106089**
21:25	28103	30217	32913	14112	1509	**106854**
21:26	28221	30309	33069	14256	1522	**107376**
21:27	28256	30498	33124	14391	1521	**107790**
21:28	28280	30620	33198	14435	1511	**108045**
21:29	28319	30706	33332	14592	1519	**108468**
21:30	28433	30777	33394	14689	1515	**108808**

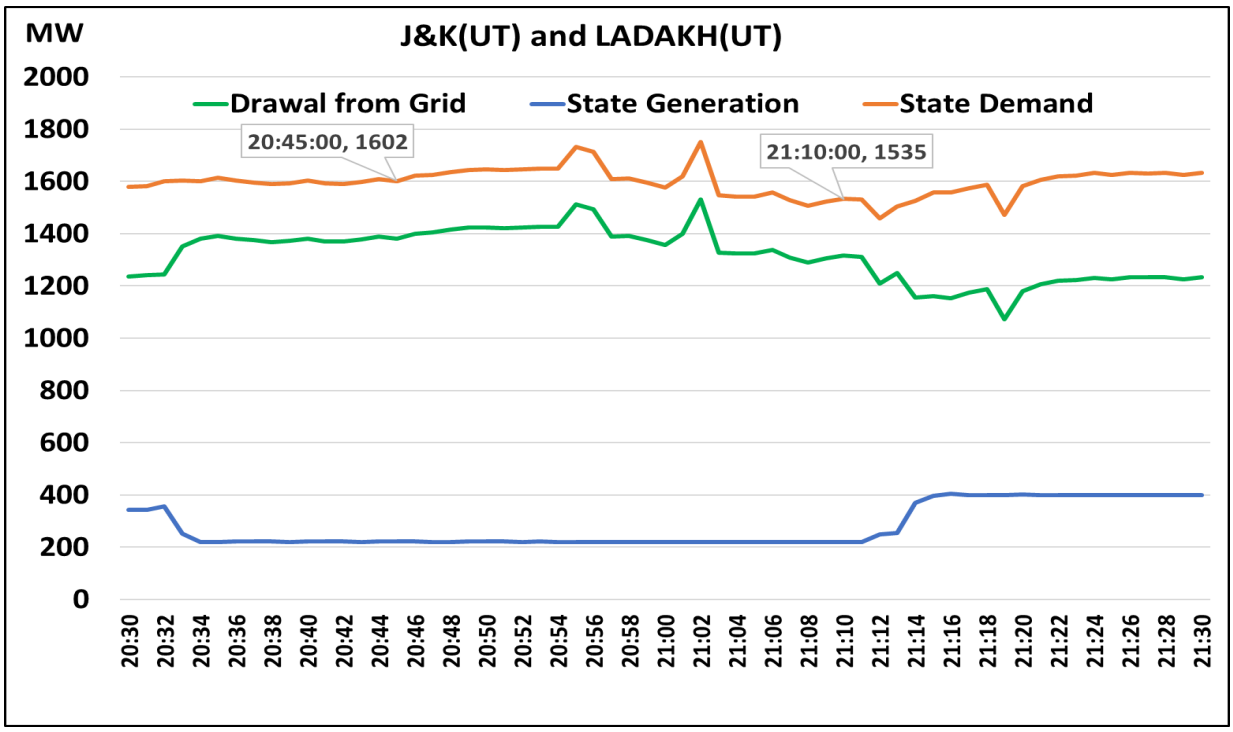
Annexure 6.1 State Drawl Patterns

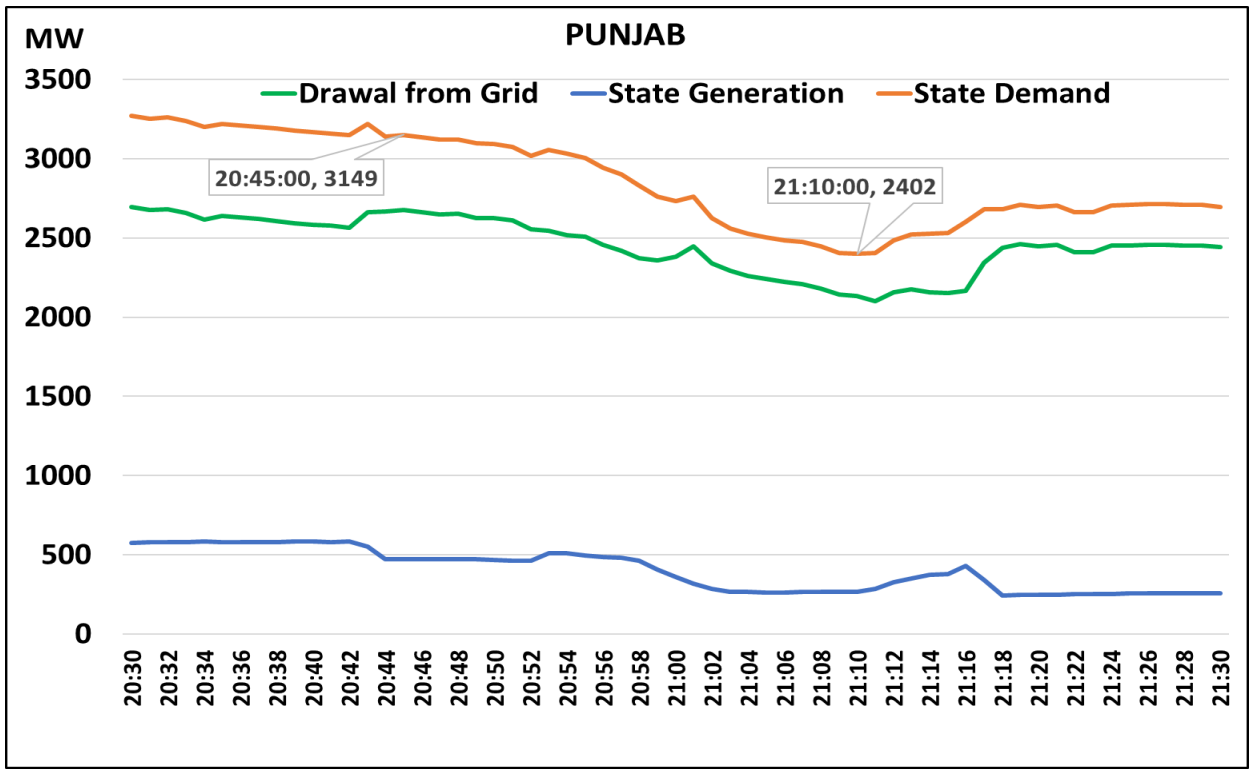


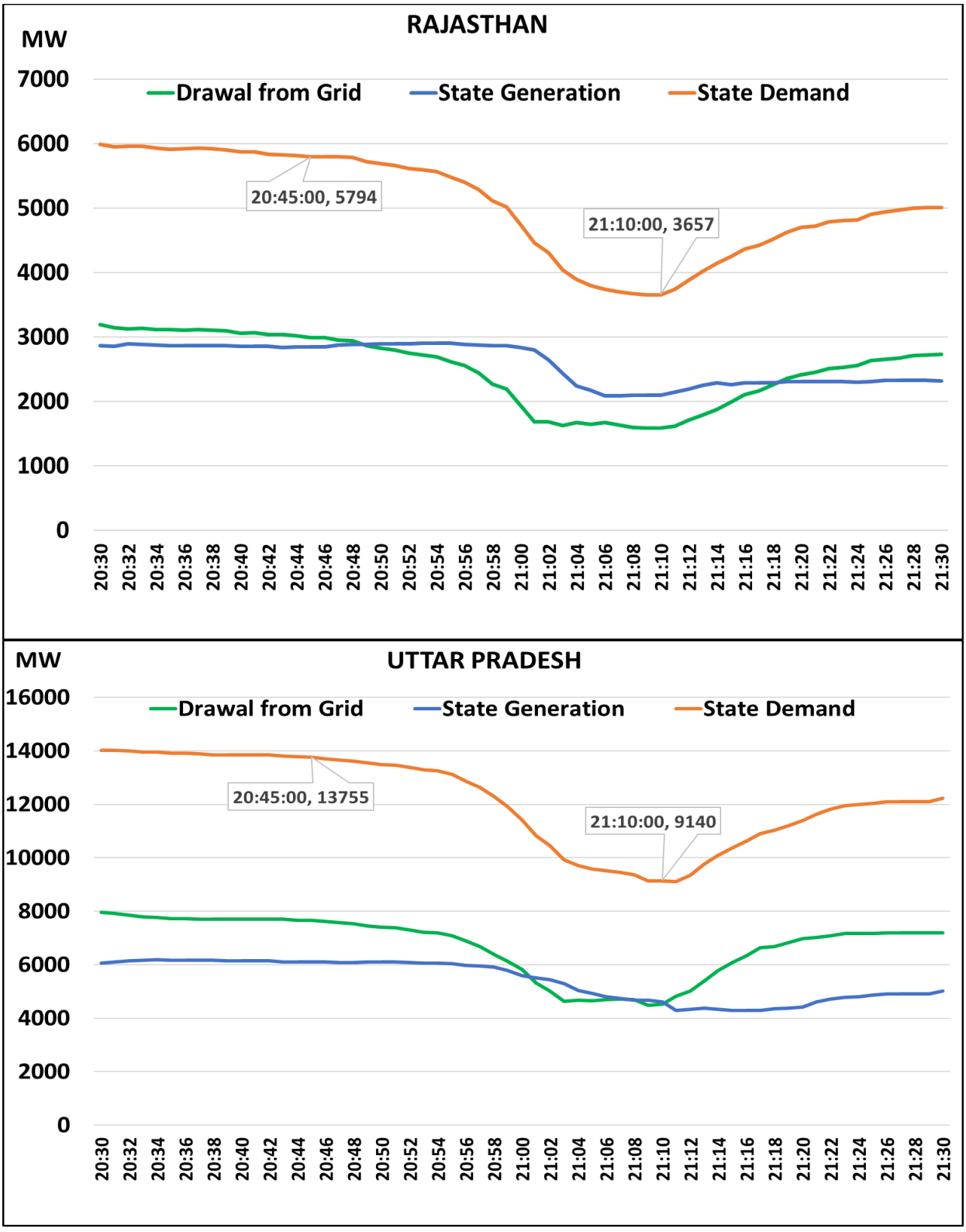


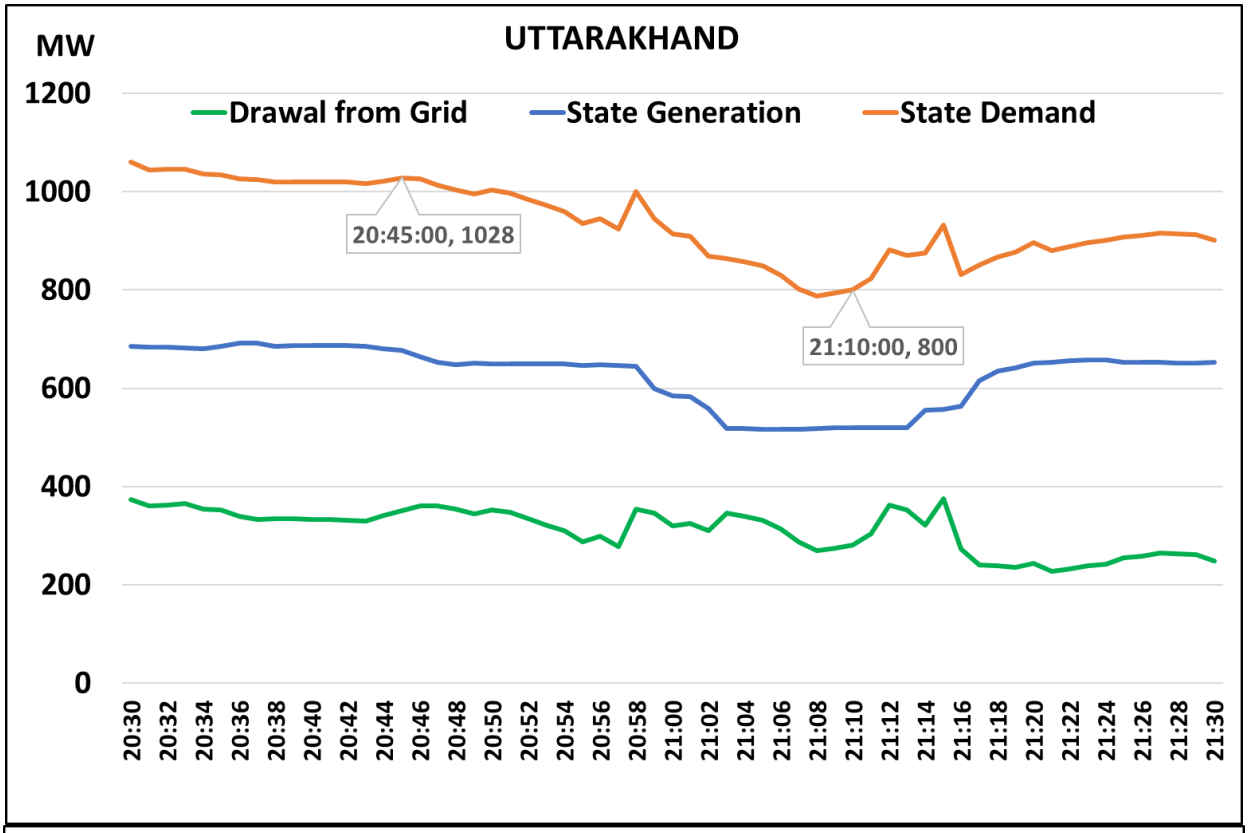

HARYANA
MW
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Drawal from Grid
State Generation
State Demand
20:45:00, 3745
21:10:00, 2790
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

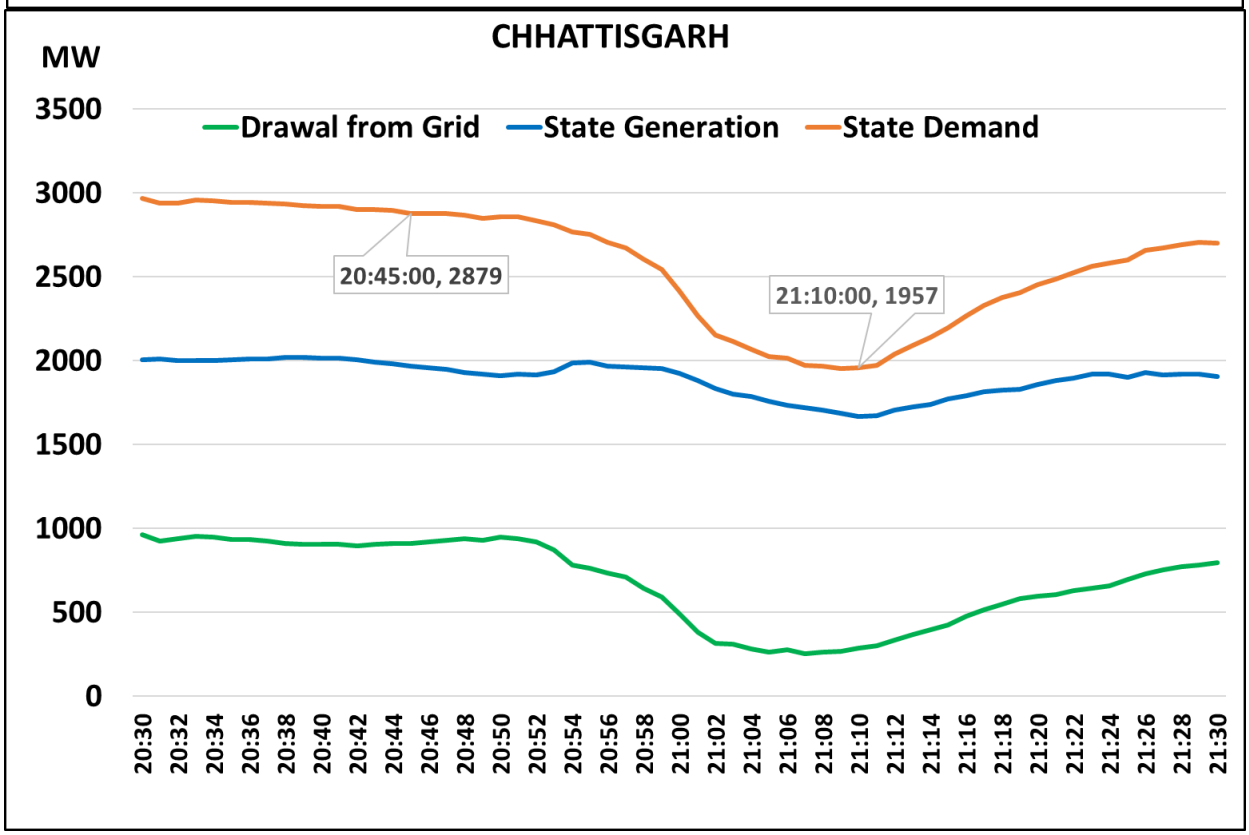

HIMACHAL PRADESH
MW
700
600
500
400
300
200
100
0
Drawal from Grid
State Generation
State Demand
20:45:00, 581
21:10:00, 391
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

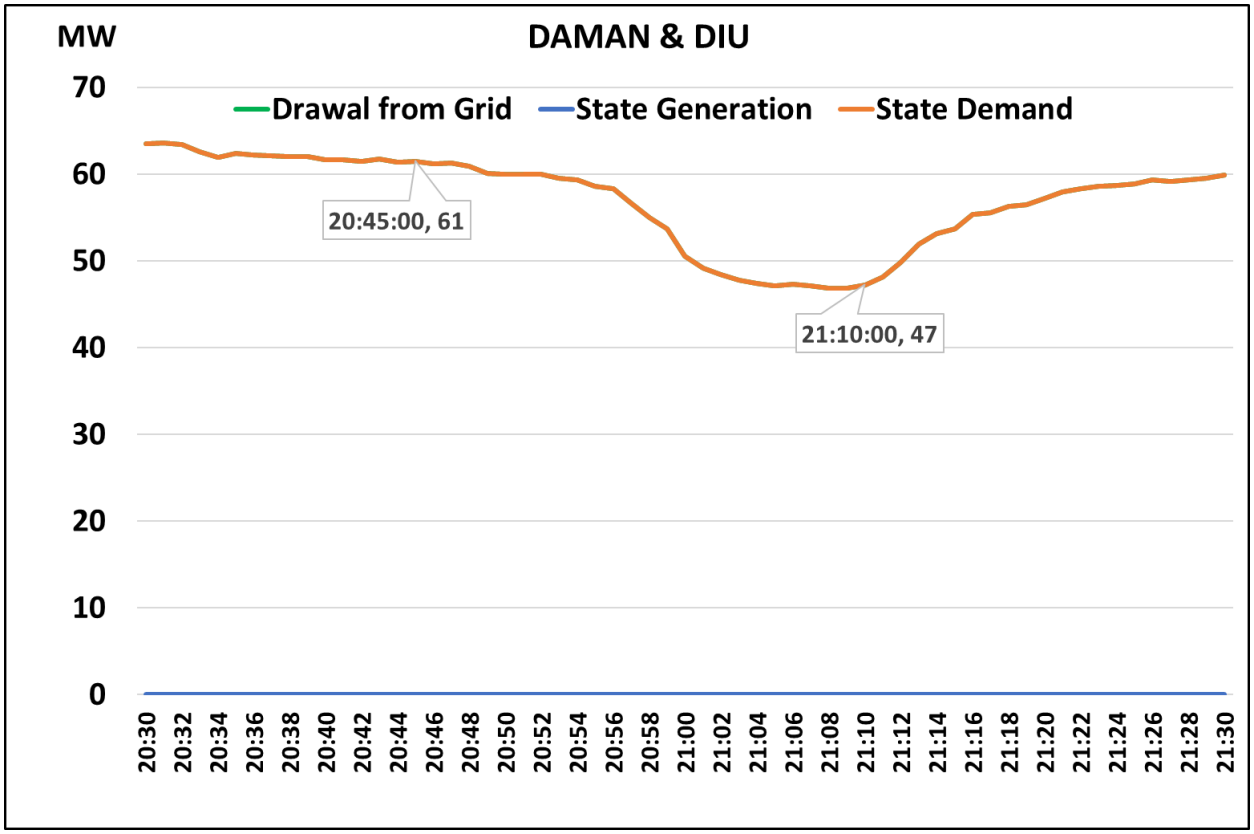

J&K(UT) and LADAKH(UT)
MW
Drawal from Grid
State Generation
State Demand
20:45:00, 1602
21:10:00, 1535
2000
1800
1600
1400
1200
1000
800
600
400
200
0
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

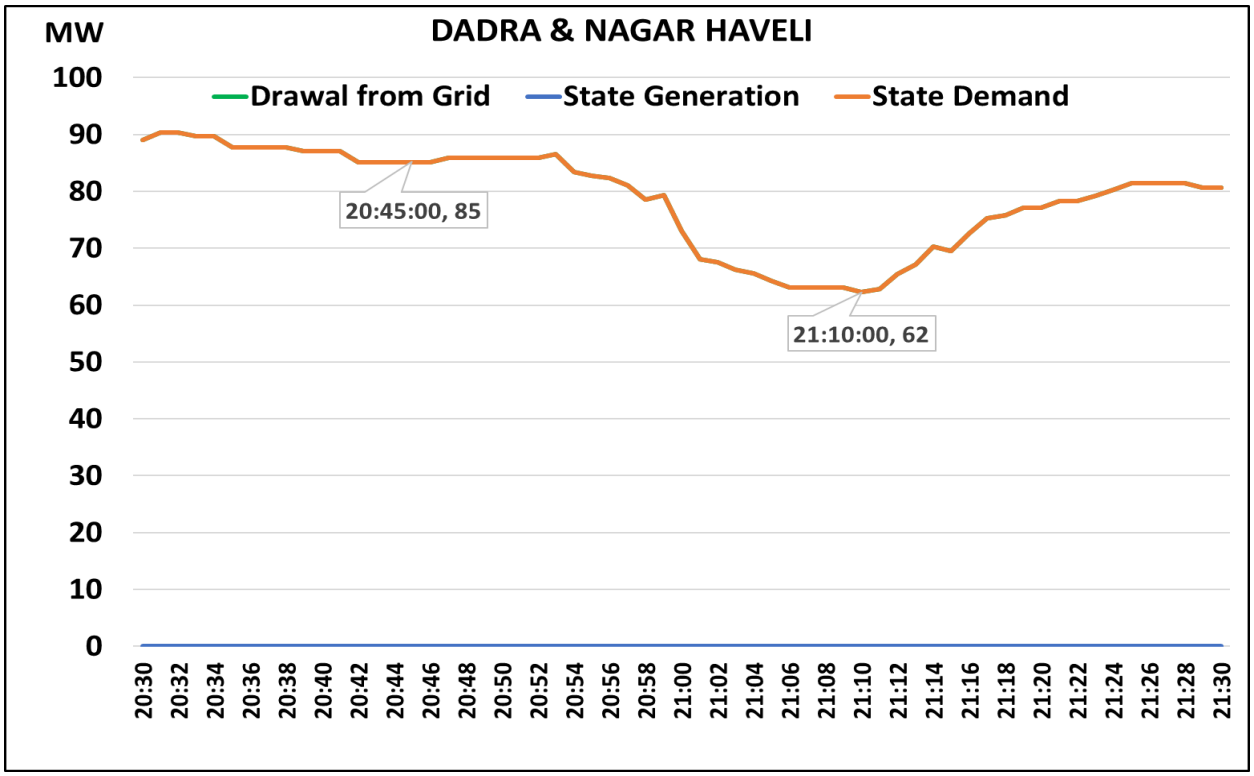

PUNJAB
MW
Drawal from Grid
State Generation
State Demand
20:45:00, 3149
21:10:00, 2402
3500
3000
2500
2000
1500
1000
500
0
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

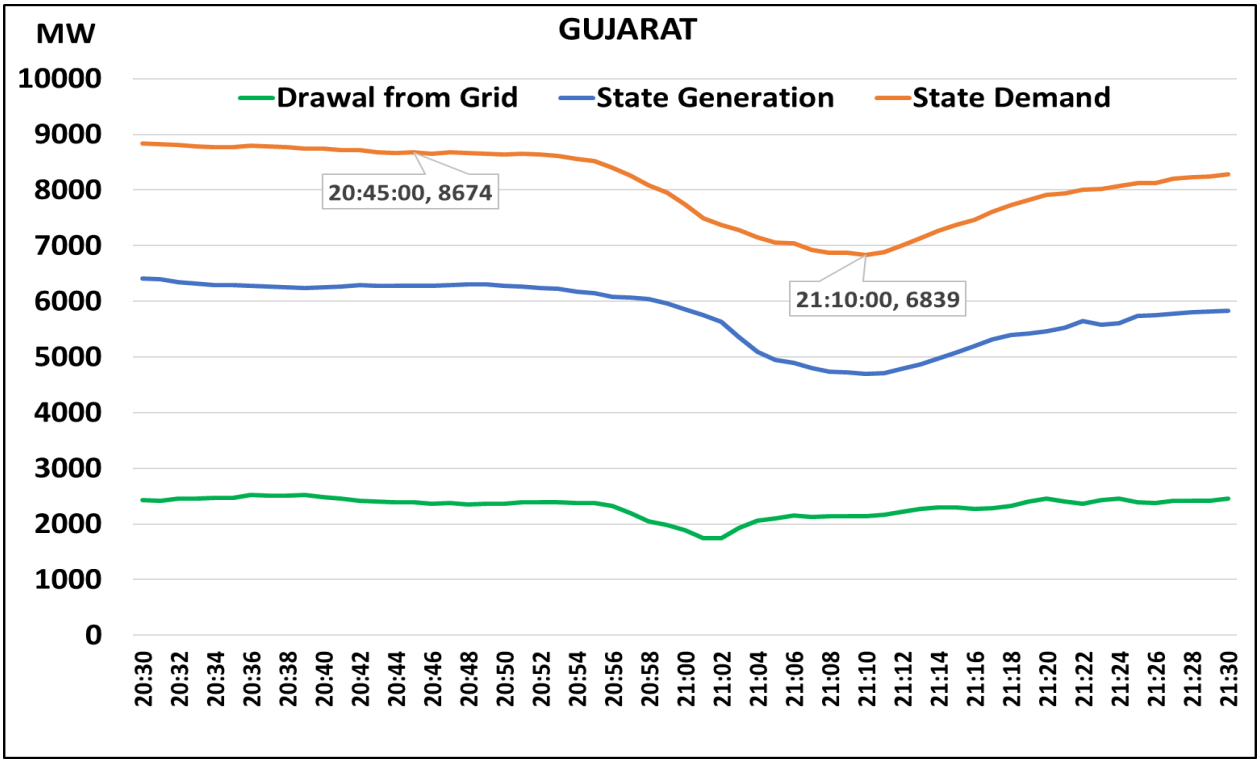

RAJASTHAN
MW
7000
6000
5000
4000
3000
2000
1000
0
Drawal from Grid
State Generation
State Demand
20:45:00, 5794
21:10:00, 3657
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30
UTTAR PRADESH
MW
16000
14000
12000
10000
8000
6000
4000
2000
0
Drawal from Grid
State Generation
State Demand
20:45:00, 13755
21:10:00, 9140
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

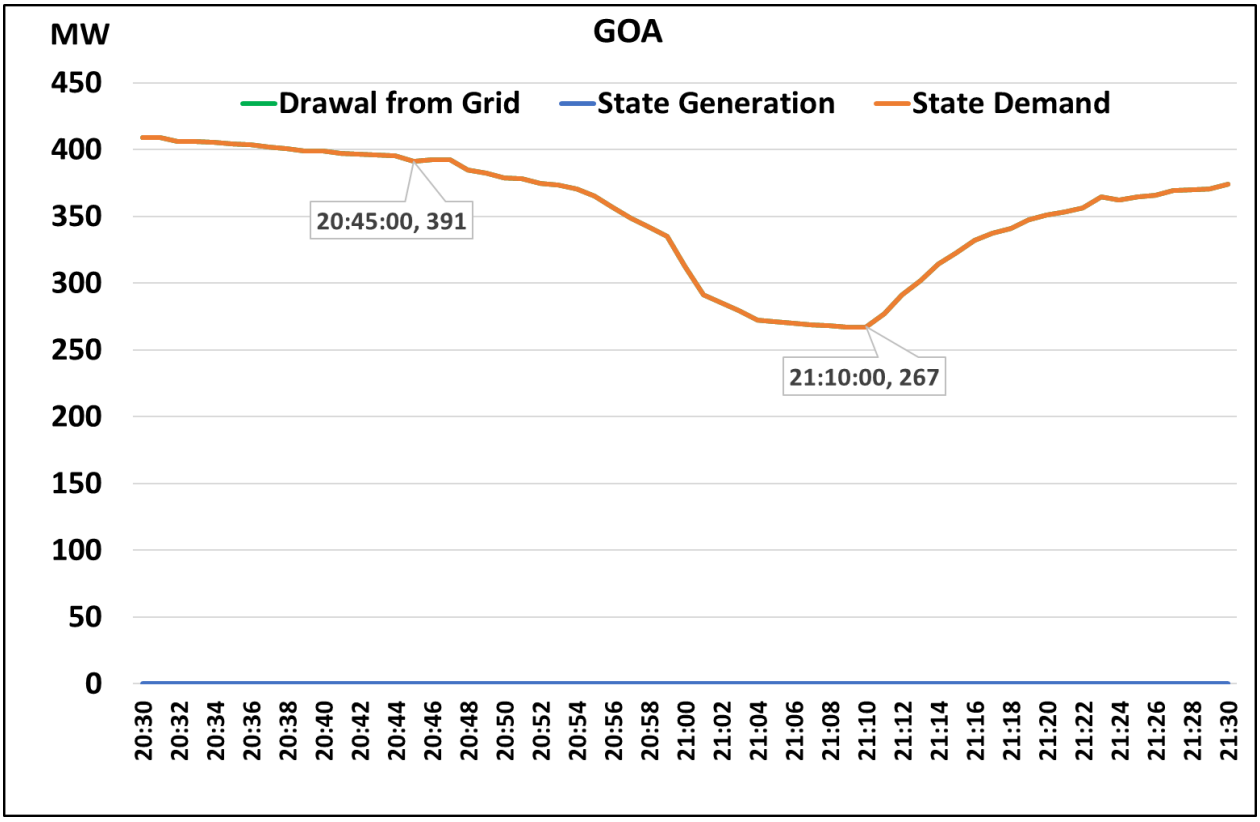

UTTARAKHAND
MW
1200
1000
800
600
400
200
0
Drawal from Grid
State Generation
State Demand
20:45:00, 1028
21:10:00, 800
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


CHHATTISGARH
MW
3500
3000
2500
2000
1500
1000
500
0
Drawal from Grid
State Generation
State Demand
20:45:00, 2879
21:10:00, 1957
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


DAMAN & DIU
MW
Drawal from Grid
State Generation
State Demand
20:45:00, 61
21:10:00, 47


DADRA & NAGAR HAVELI
MW
Drawal from Grid
State Generation
State Demand
20:45:00, 85
21:10:00, 62


GUJARAT
MW
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Drawal from Grid
State Generation
State Demand
20:45:00, 8674
21:10:00, 6839
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


GOA
MW
450
400
350
300
250
200
150
100
50
0
Drawal from Grid
State Generation
State Demand
20:45:00, 391
21:10:00, 267
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
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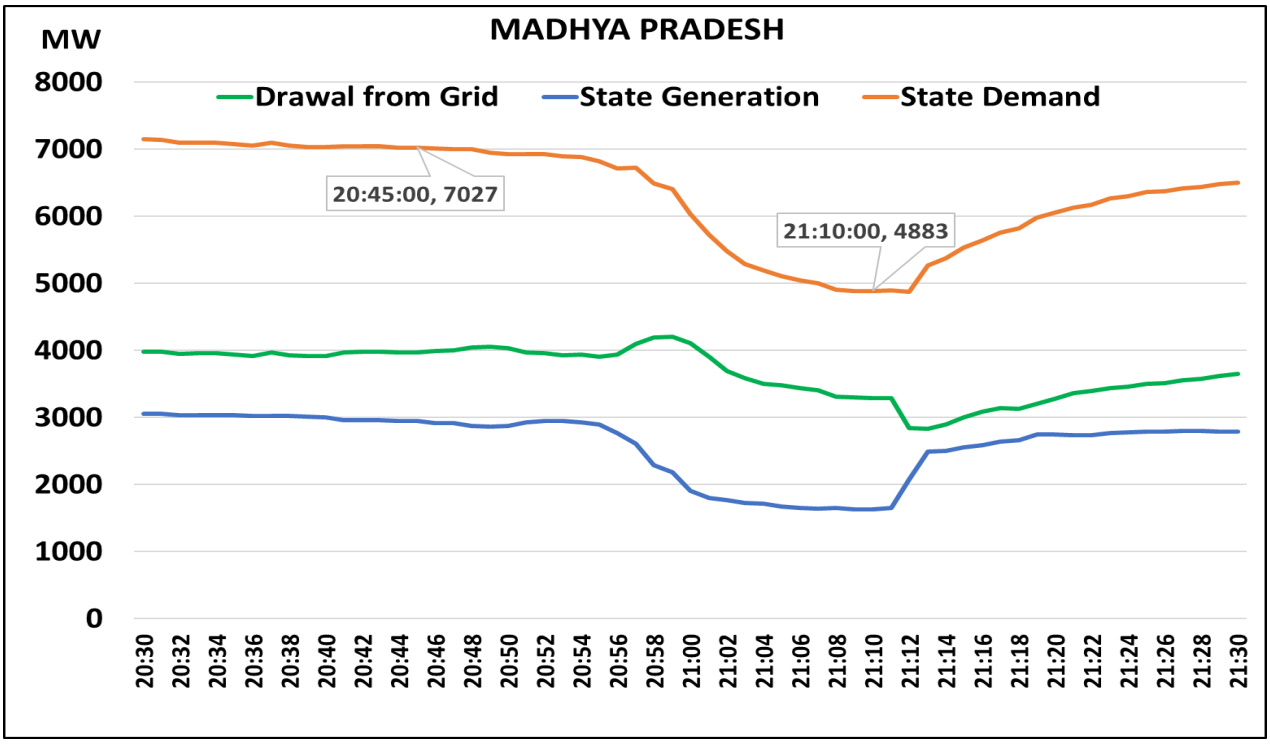
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


MADHYA PRADESH
MW
8000
7000
6000
5000
4000
3000
2000
1000
0
Drawal from Grid
State Generation
State Demand
20:45:00, 7027
21:10:00, 4883
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
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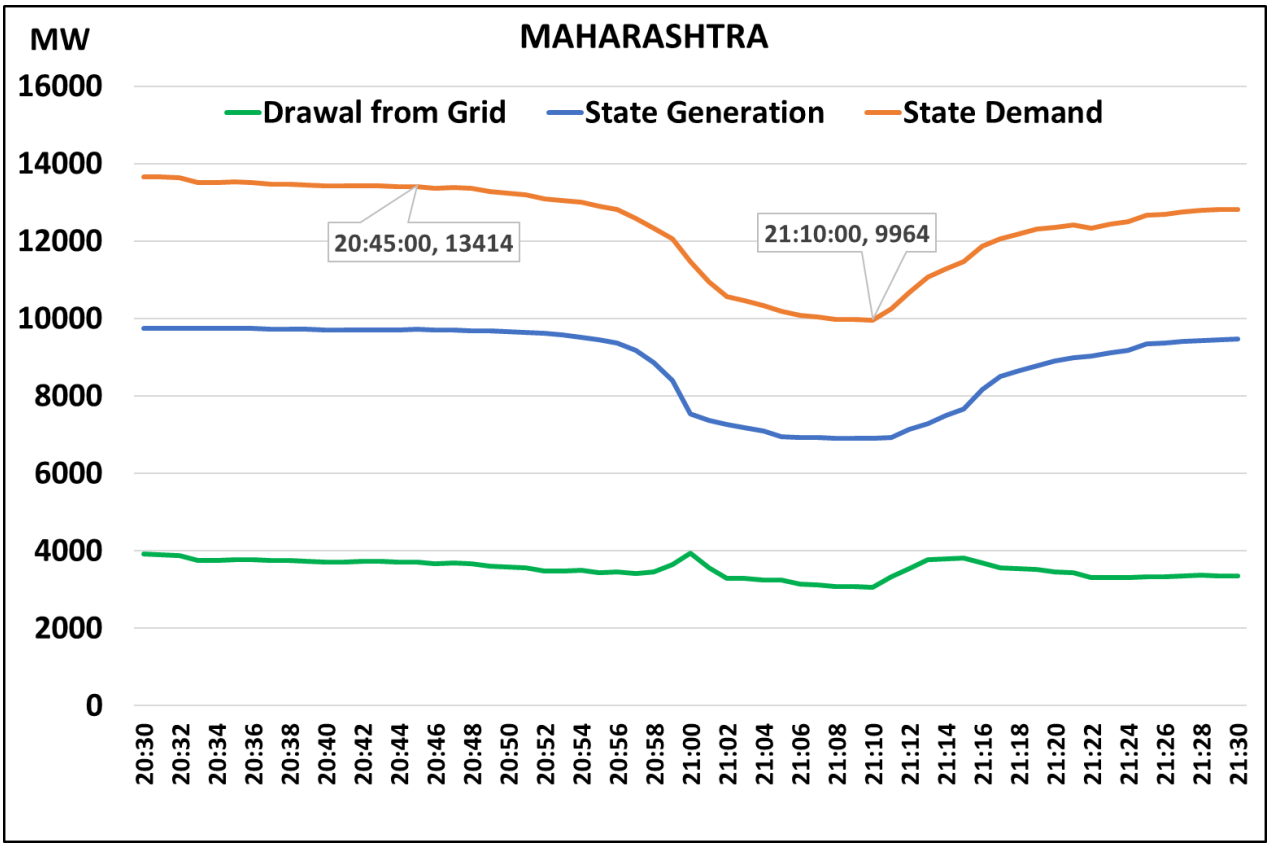
MAHARASHTRA
MW
16000
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12000
10000
8000
6000
4000
2000
0
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State Generation
State Demand
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21:10:00, 9964
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21:00
21:02
21:04
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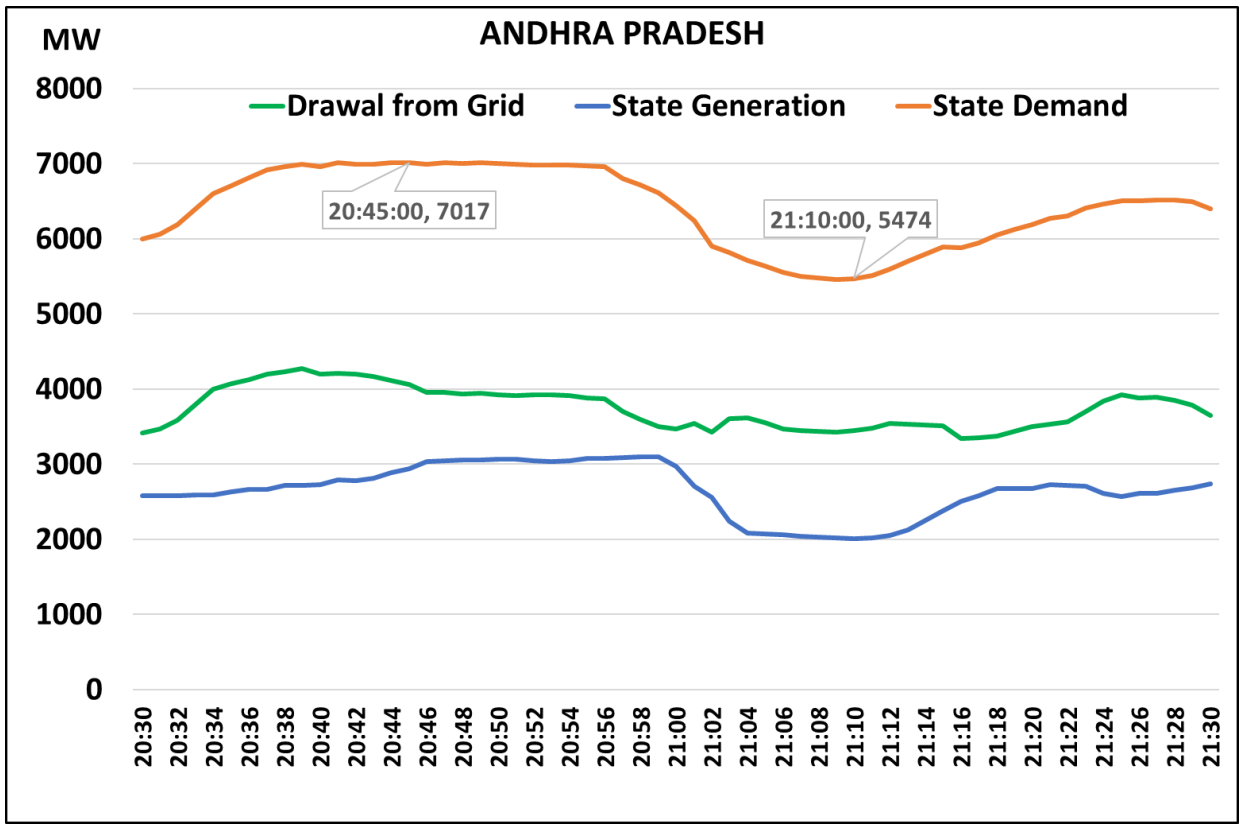
ANDHRA PRADESH
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1000
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State Generation
State Demand
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21:10:00, 5474
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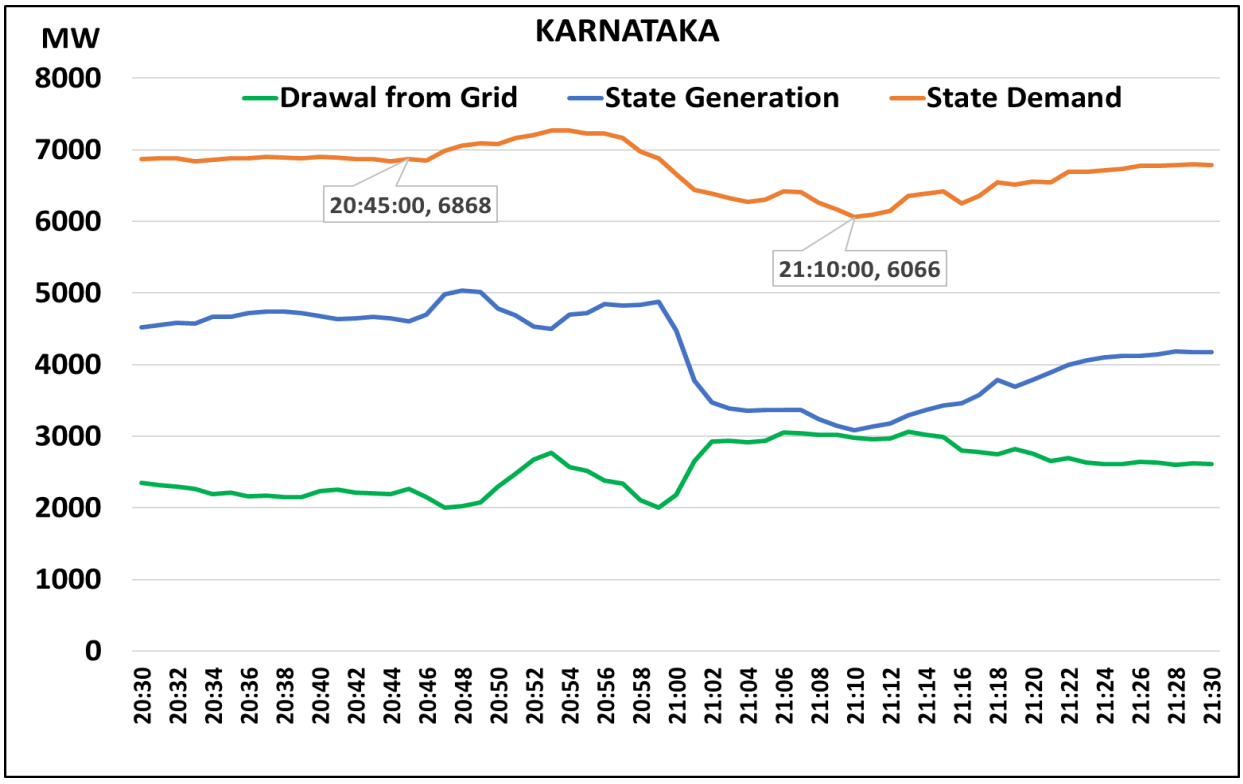
KARNATAKA
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State Generation
State Demand
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21:10:00, 6066
20:30
20:32
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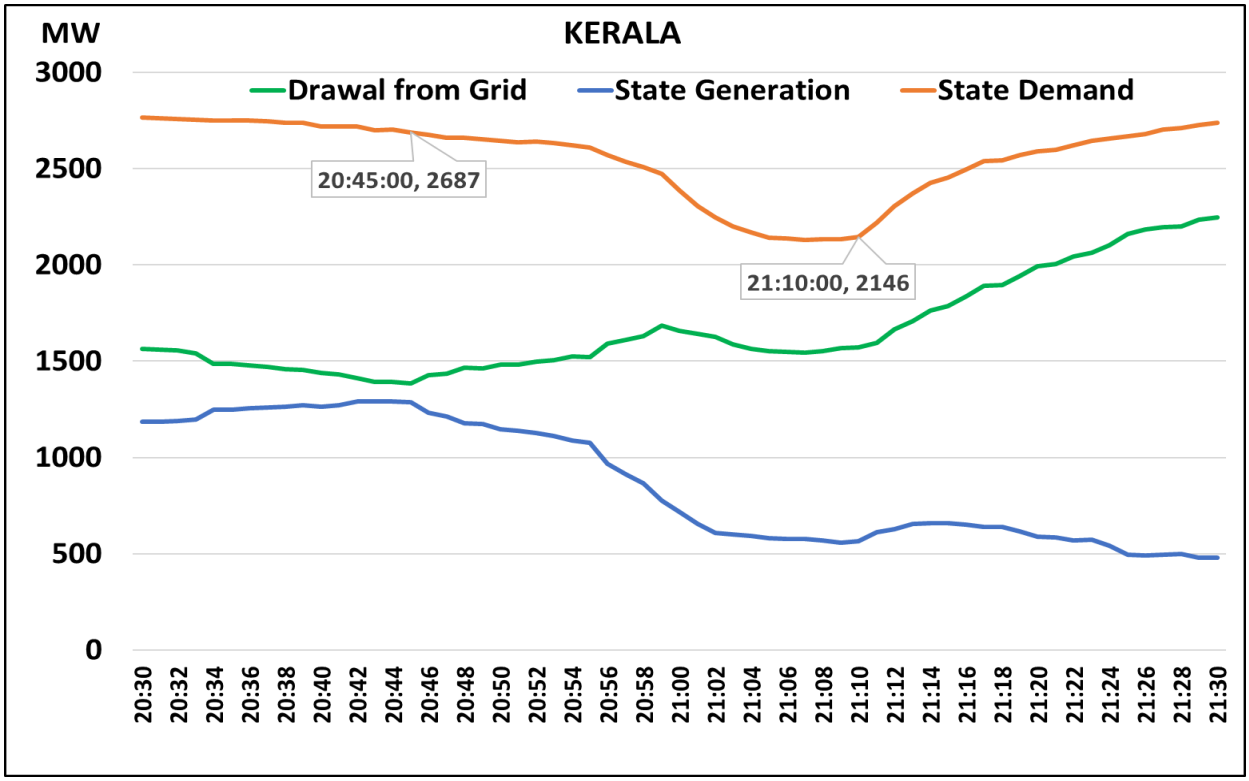
KERALA
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1500
1000
500
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Drawal from Grid
State Generation
State Demand
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21:10:00, 2146
20:30
20:32
20:34
20:36
20:38
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20:42
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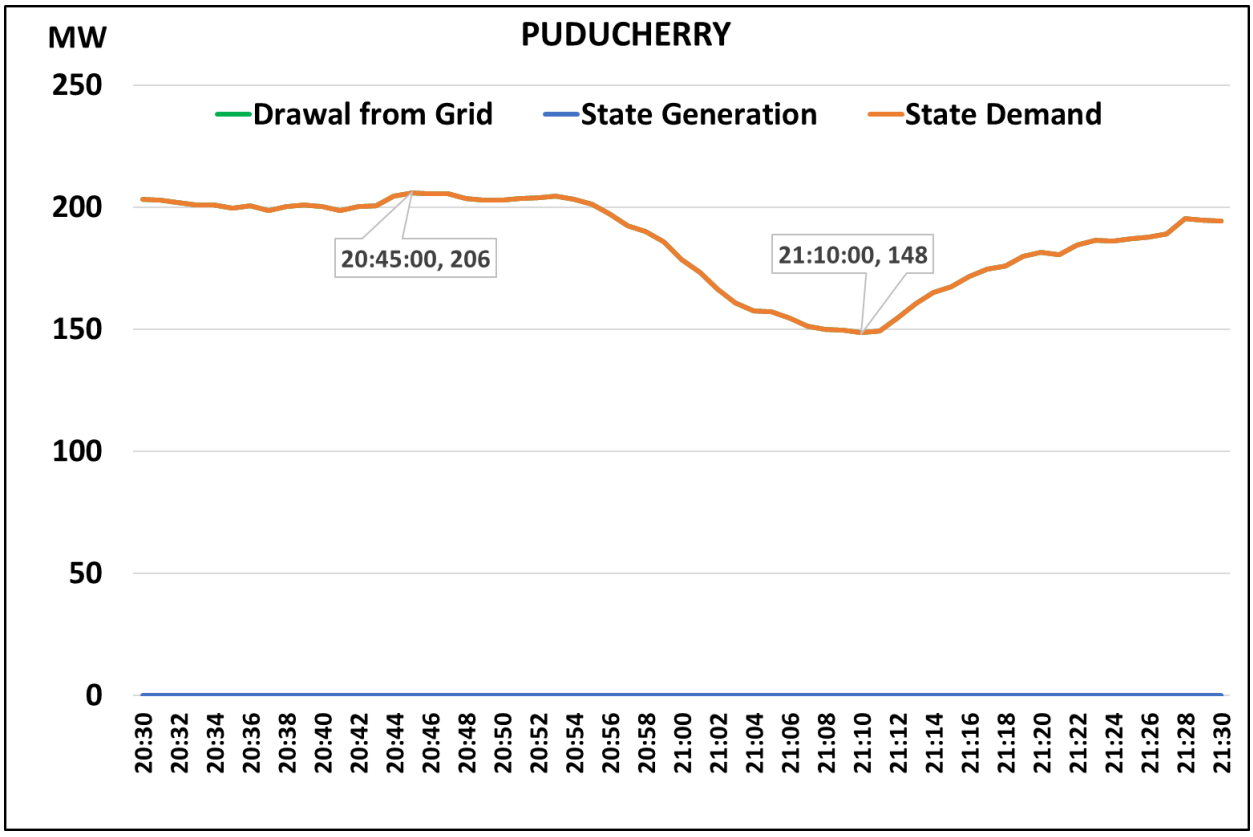
PUDUCHERRY
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150
100
50
0
Drawal from Grid
State Generation
State Demand
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21:10:00, 148
20:30
20:32
20:34
20:36
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20:40
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20:44
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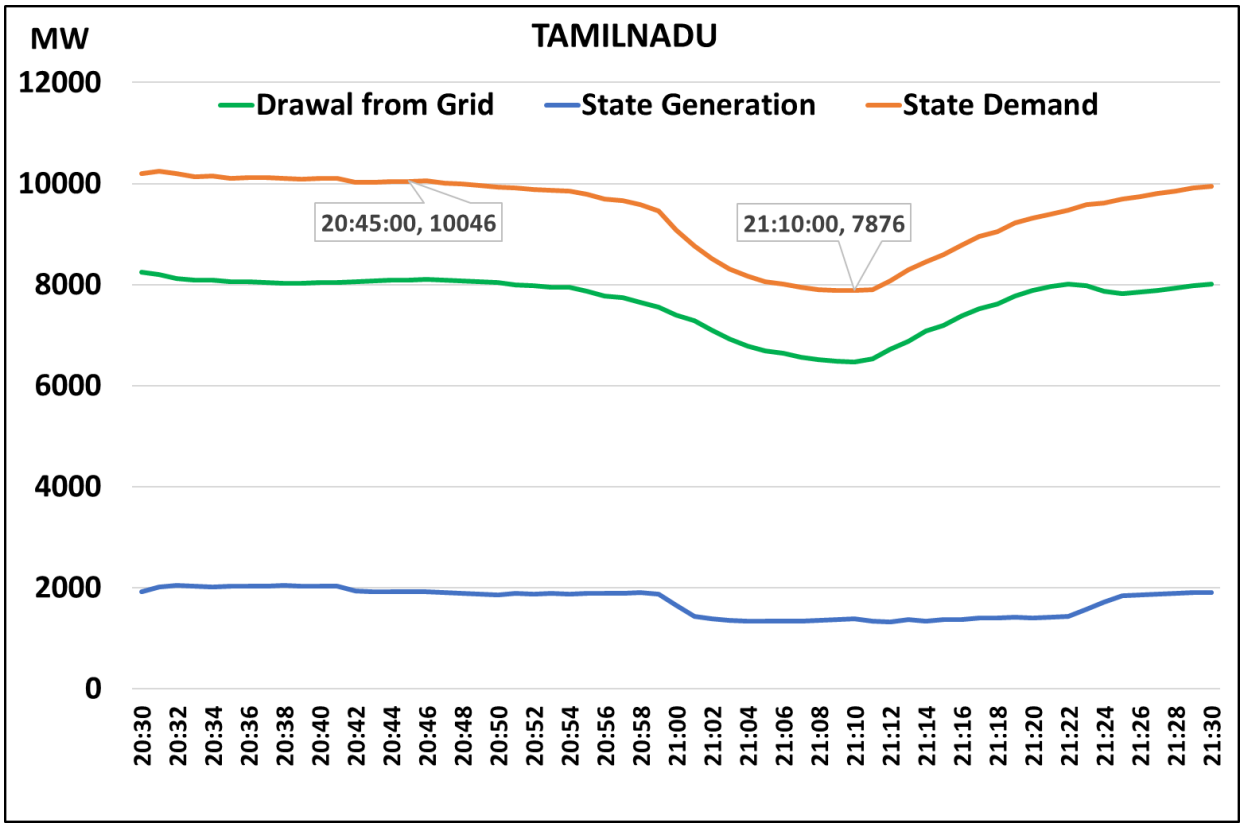
TAMILNADU
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6000
4000
2000
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Drawal from Grid
State Generation
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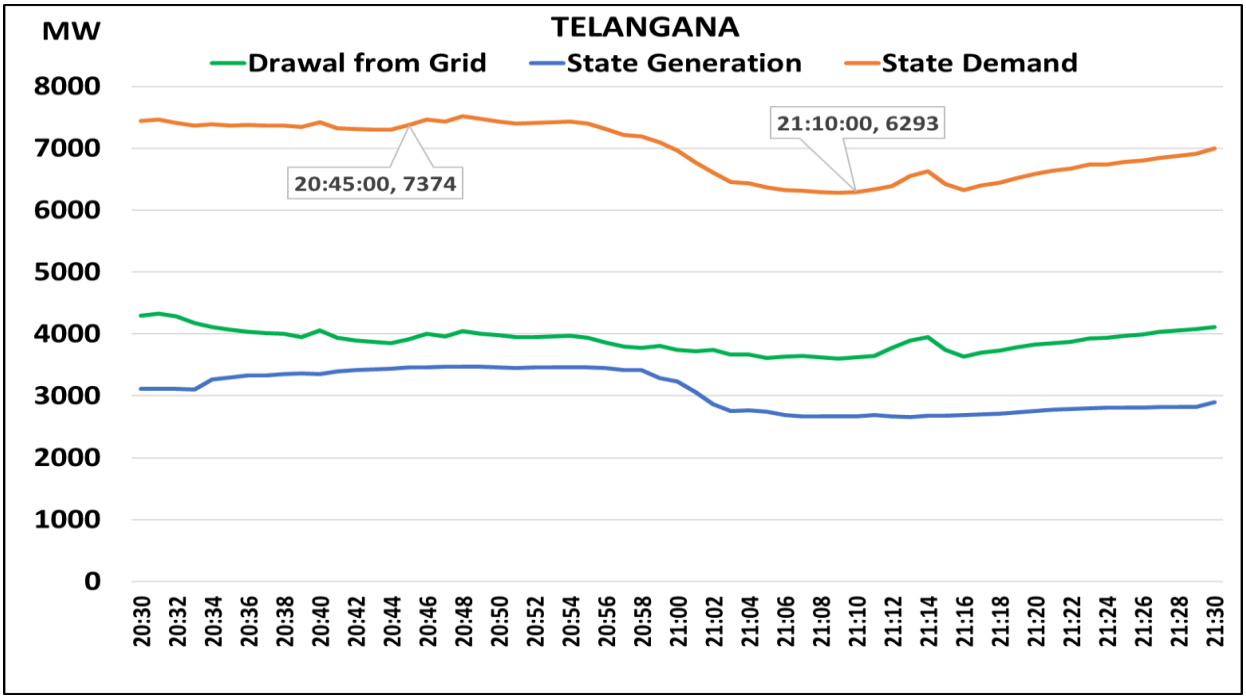
TELANGANA
MW
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5000
4000
3000
2000
1000
0
Drawal from Grid
State Generation
State Demand
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21:10:00, 6293
20:30
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20:40
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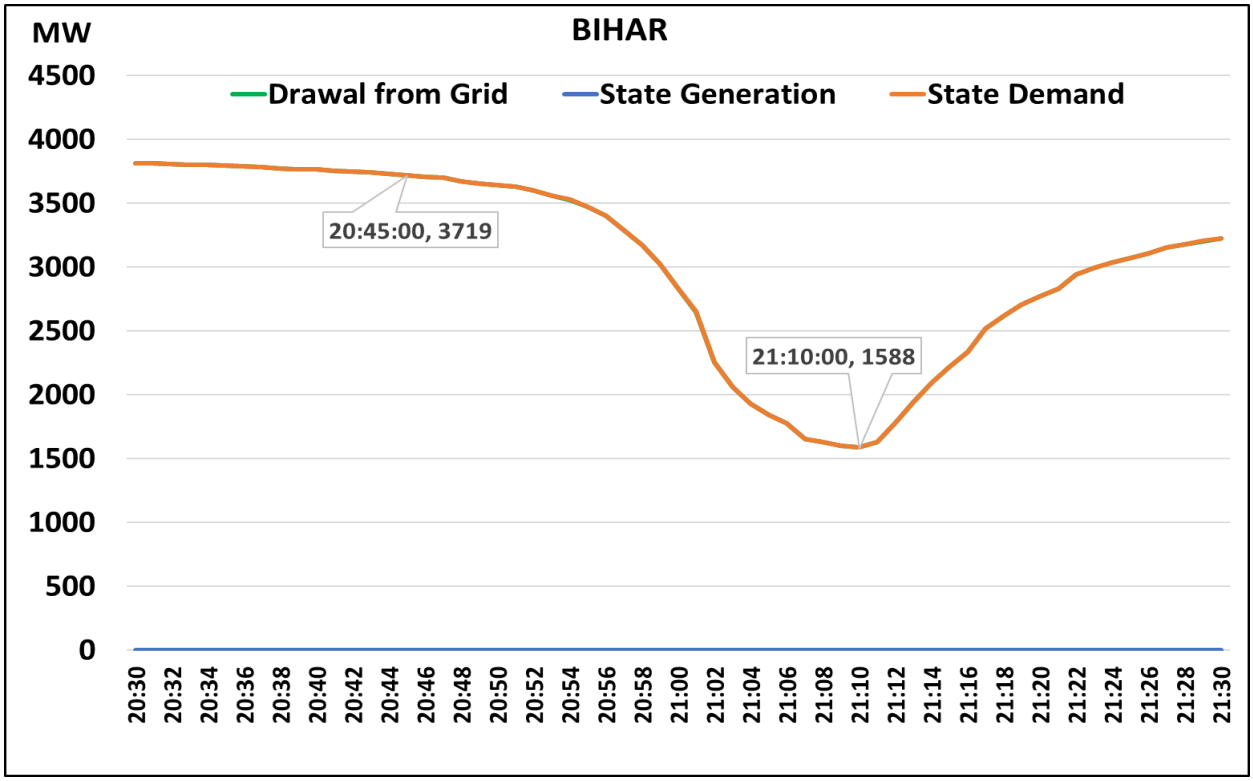
BIHAR
MW
Drawal from Grid
State Generation
State Demand
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4000
3500
3000
2500
2000
1500
1000
500
0
20:45:00, 3719
21:10:00, 1588
20:30
20:32
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20:40
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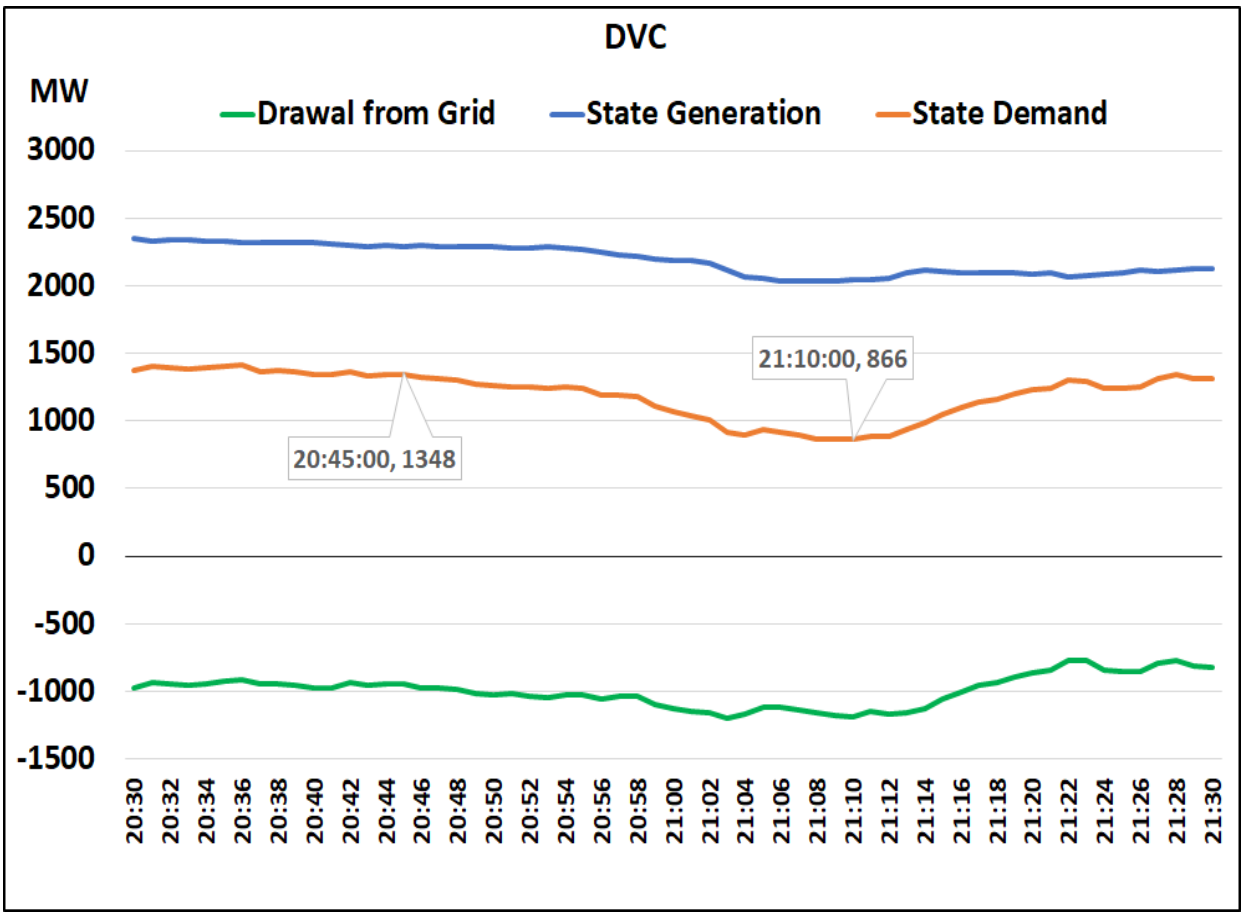
DVC
MW
Drawal from Grid
State Generation
State Demand
3000
2500
2000
1500
1000
500
0
-500
-1000
-1500
21:10:00, 866
20:45:00, 1348
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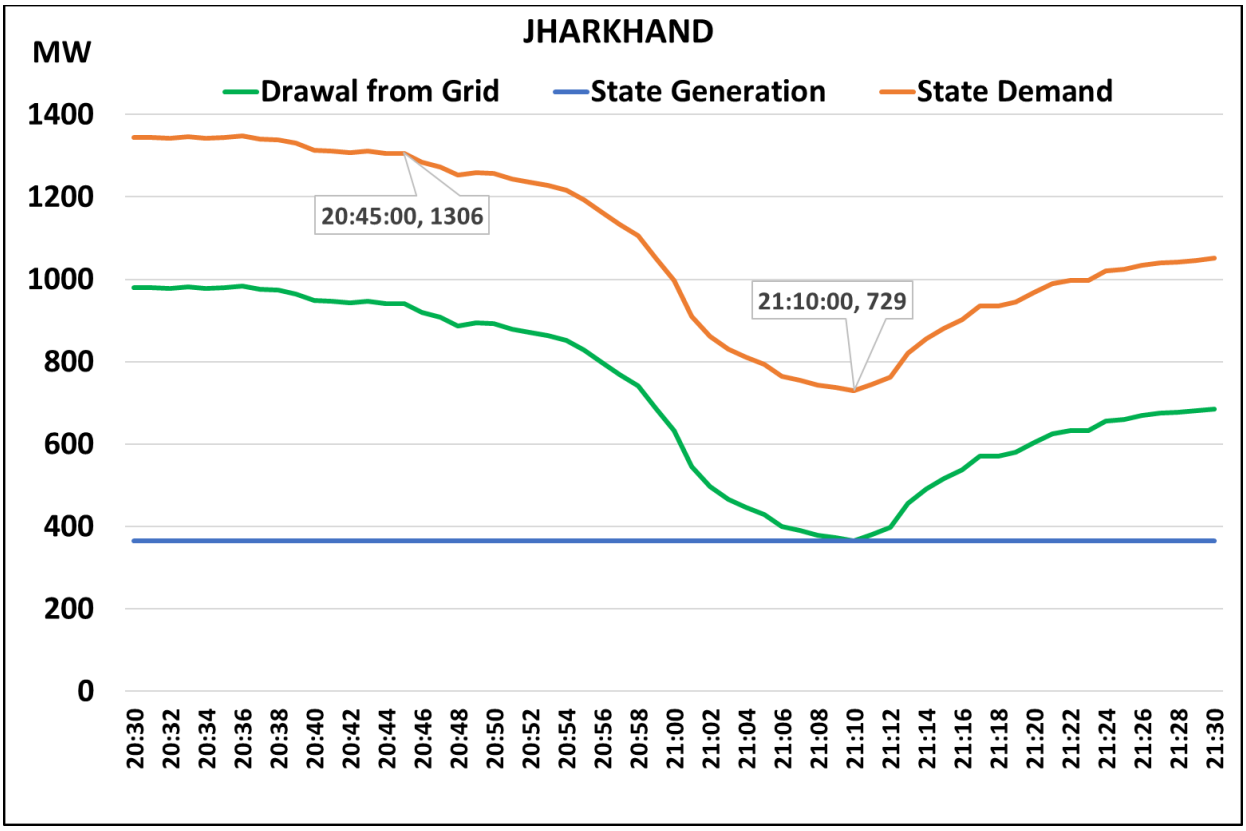
JHARKHAND
MW
Drawal from Grid
State Generation
State Demand
1400
1200
1000
800
600
400
200
0
20:45:00, 1306
21:10:00, 729
20:30
20:32
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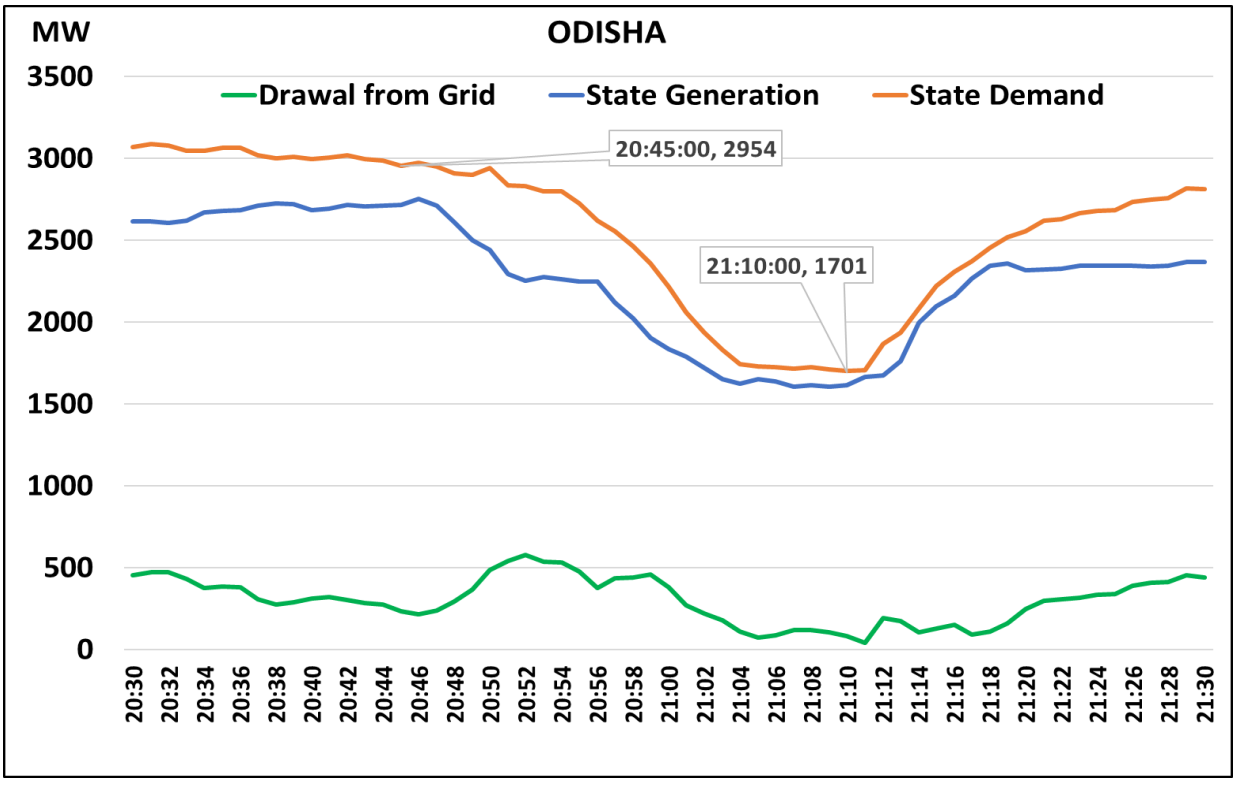
ODISHA
MW
Drawal from Grid
State Generation
State Demand
3500
3000
2500
2000
1500
1000
500
0
20:45:00, 2954
21:10:00, 1701
20:30
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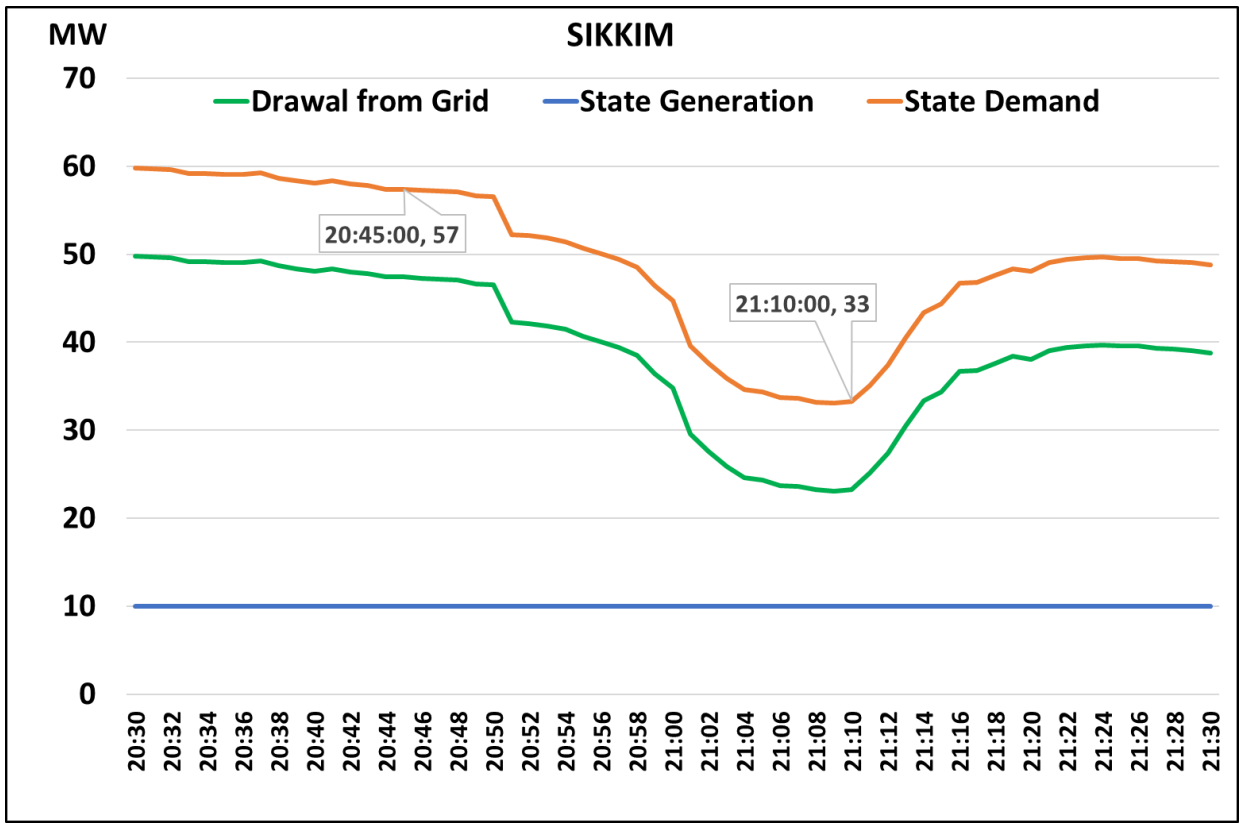
MW
SIKKIM
70
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10
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Drawal from Grid
State Generation
State Demand
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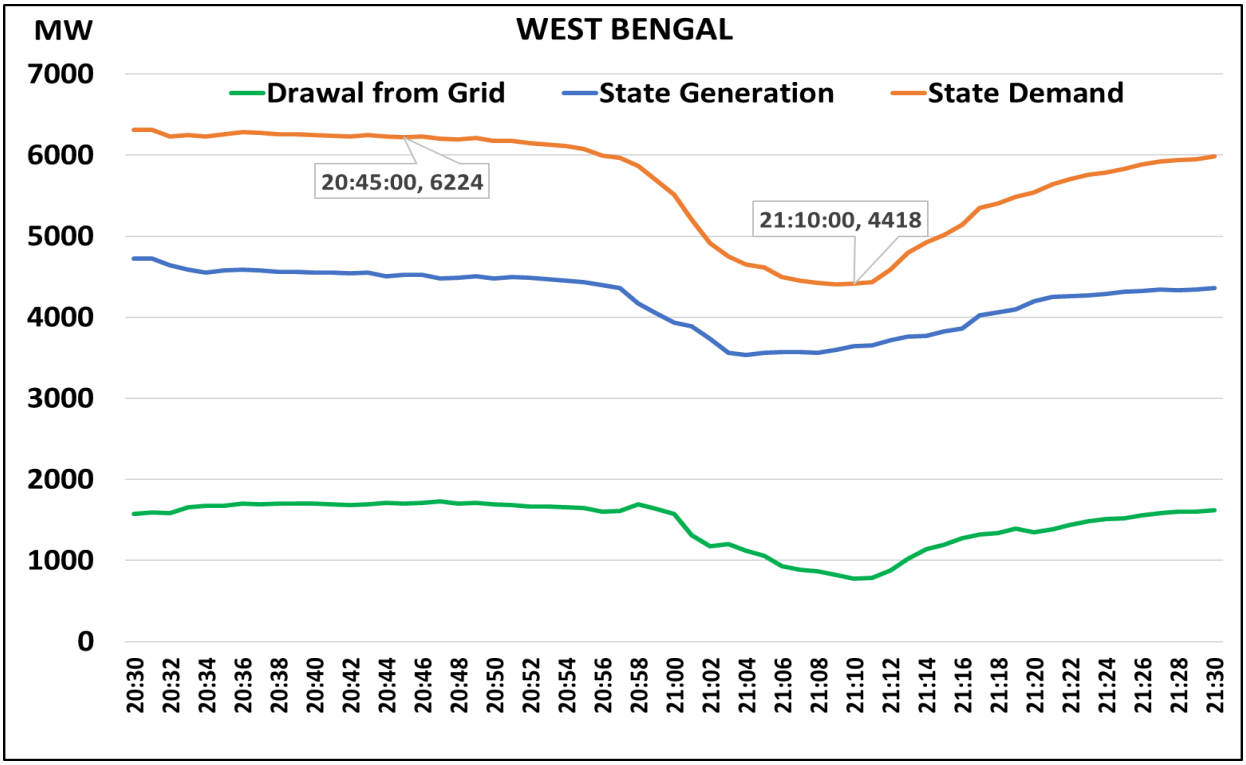
MW
WEST BENGAL
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5000
4000
3000
2000
1000
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Drawal from Grid
State Generation
State Demand
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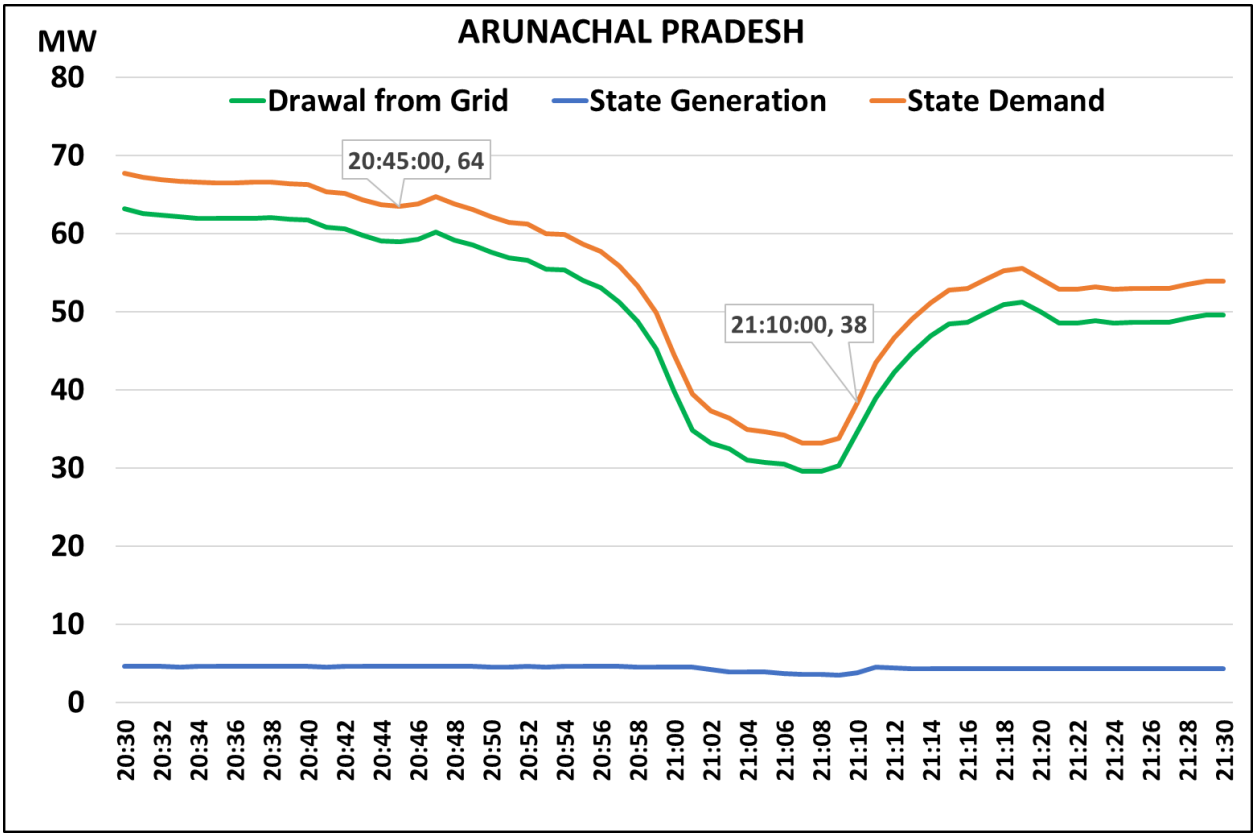
ARUNACHAL PRADESH
MW
Drawal from Grid
State Generation
State Demand
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80
70
60
50
40
30
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10
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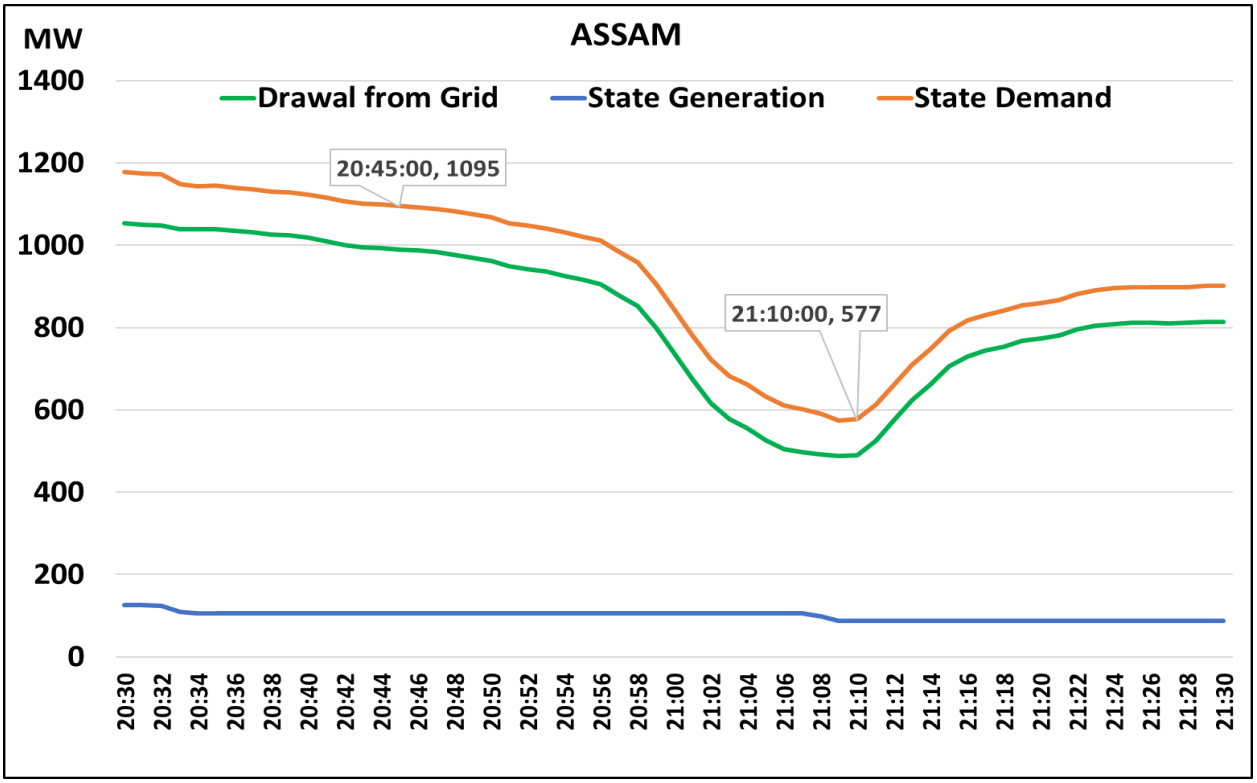
ASSAM
MW
Drawal from Grid
State Generation
State Demand
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1400
1200
1000
800
600
400
200
0
20:30
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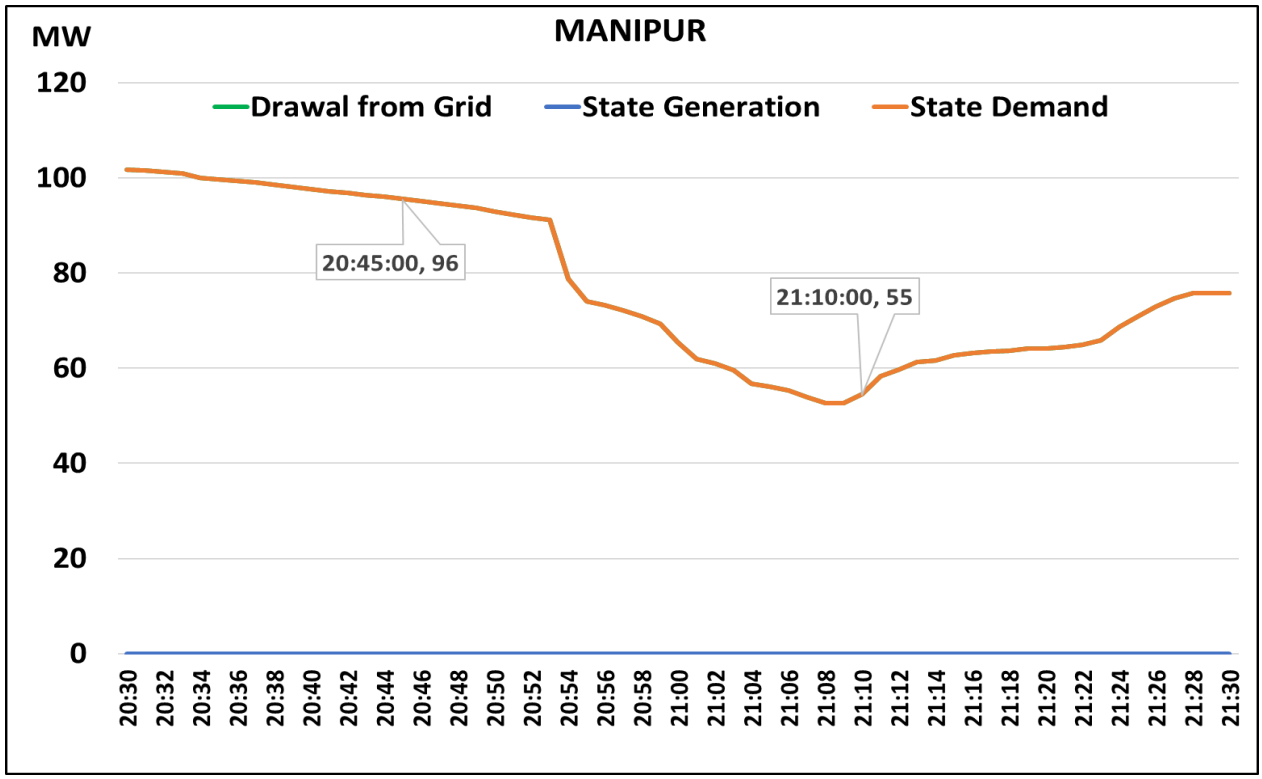
MANIPUR
MW
120
100
80
60
40
20
0
Drawal from Grid
State Generation
State Demand
20:45:00, 96
21:10:00, 55
20:30
20:32
20:34
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20:40
20:42
20:44
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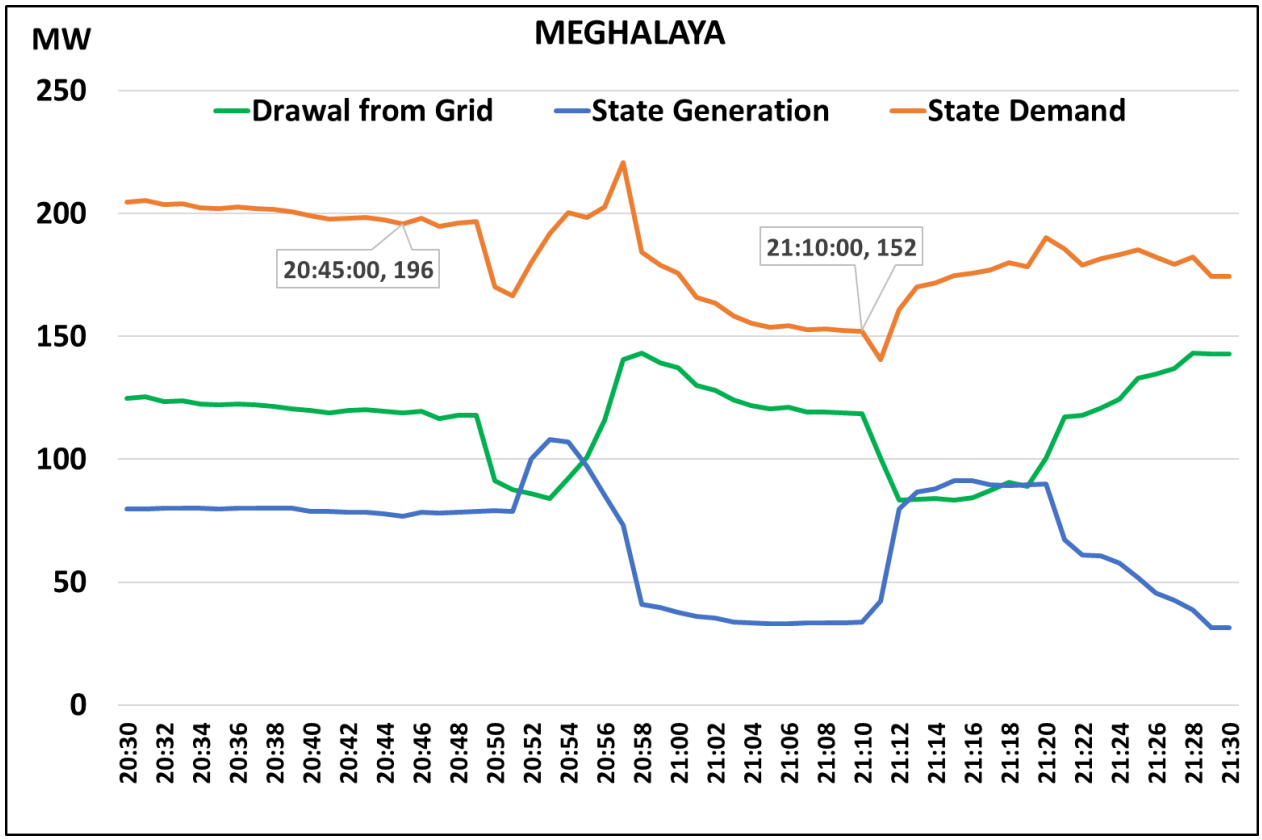
MEGHALAYA
MW
250
200
150
100
50
0
Drawal from Grid
State Generation
State Demand
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21:10:00, 152
20:30
20:32
20:34
20:36
20:38
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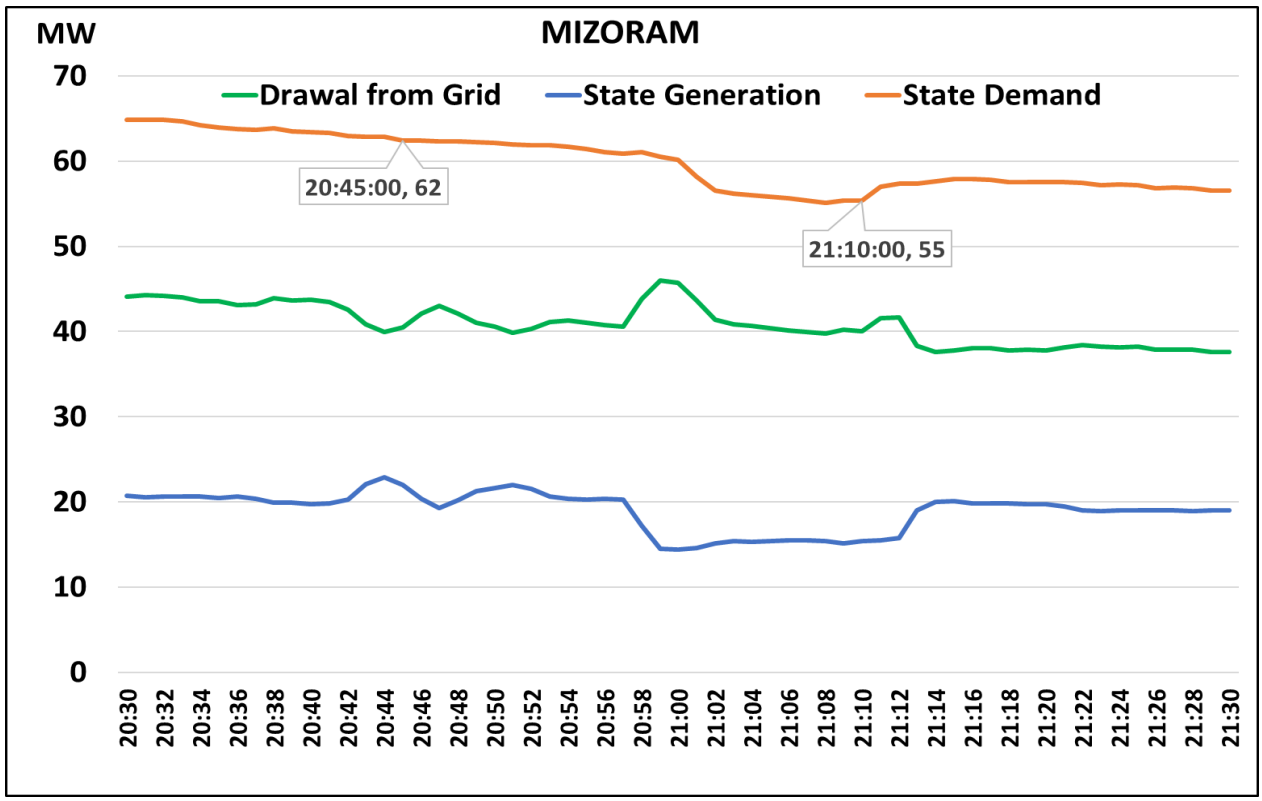
MIZORAM
MW
Drawal from Grid
State Generation
State Demand
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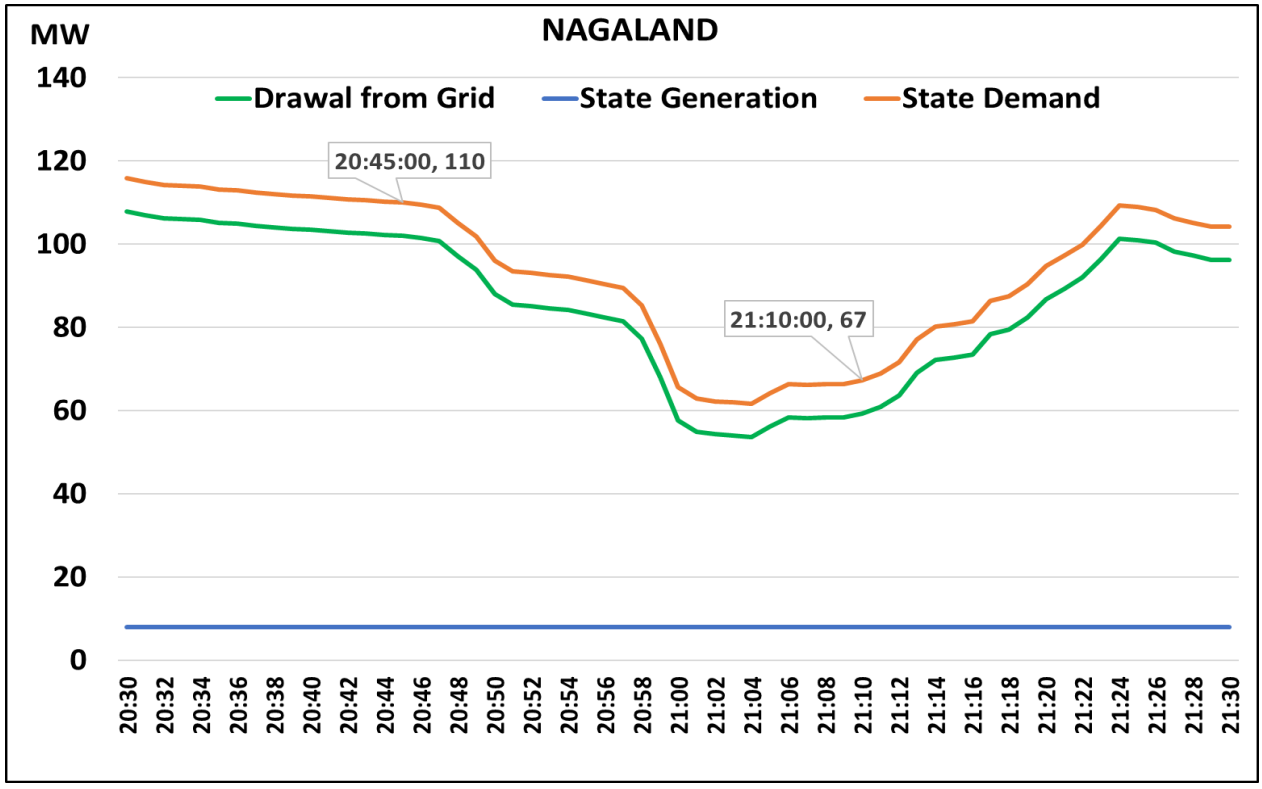
21:10:00, 55


NAGALAND
MW
Drawal from Grid
State Generation
State Demand
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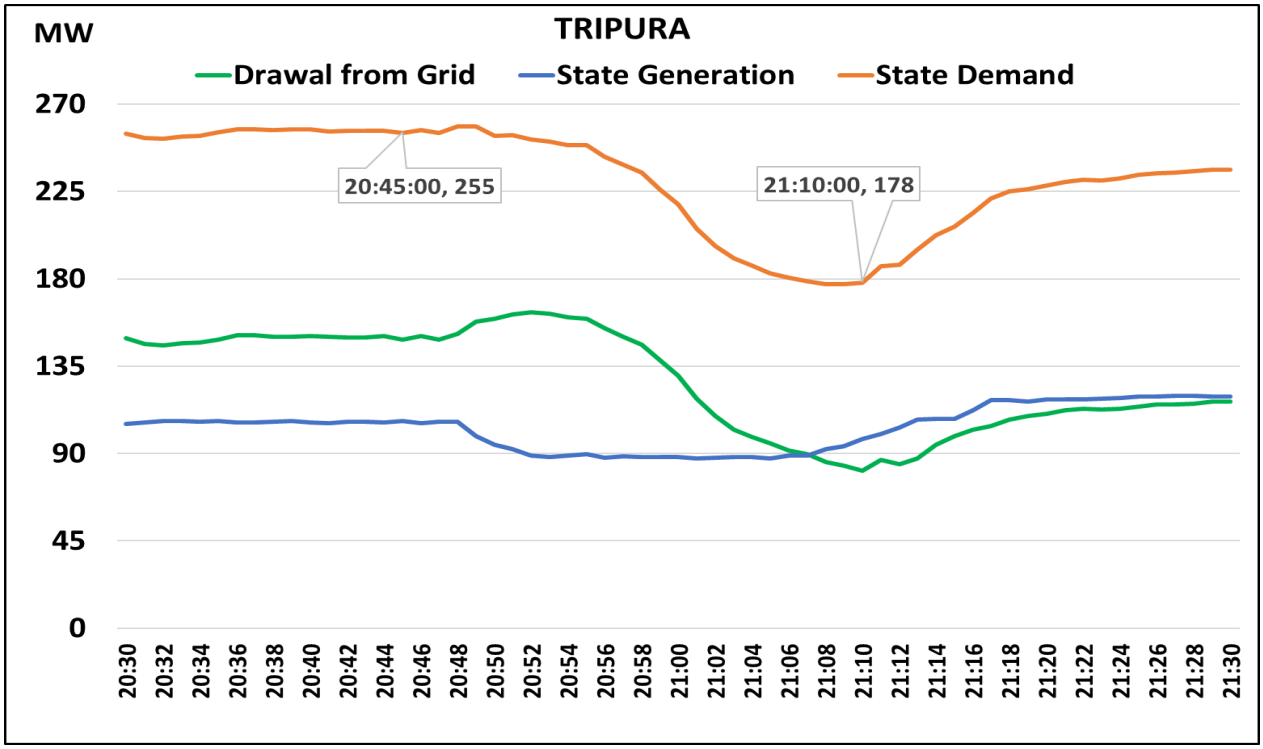
21:10:00, 67


TRIPURA
MW
Drawal from Grid
State Generation
State Demand
270
225
180
135
90
45
0
20:45:00, 255
21:10:00, 178
20:30
20:32
20:34
20:36
20:38
20:40
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20:50
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21:00
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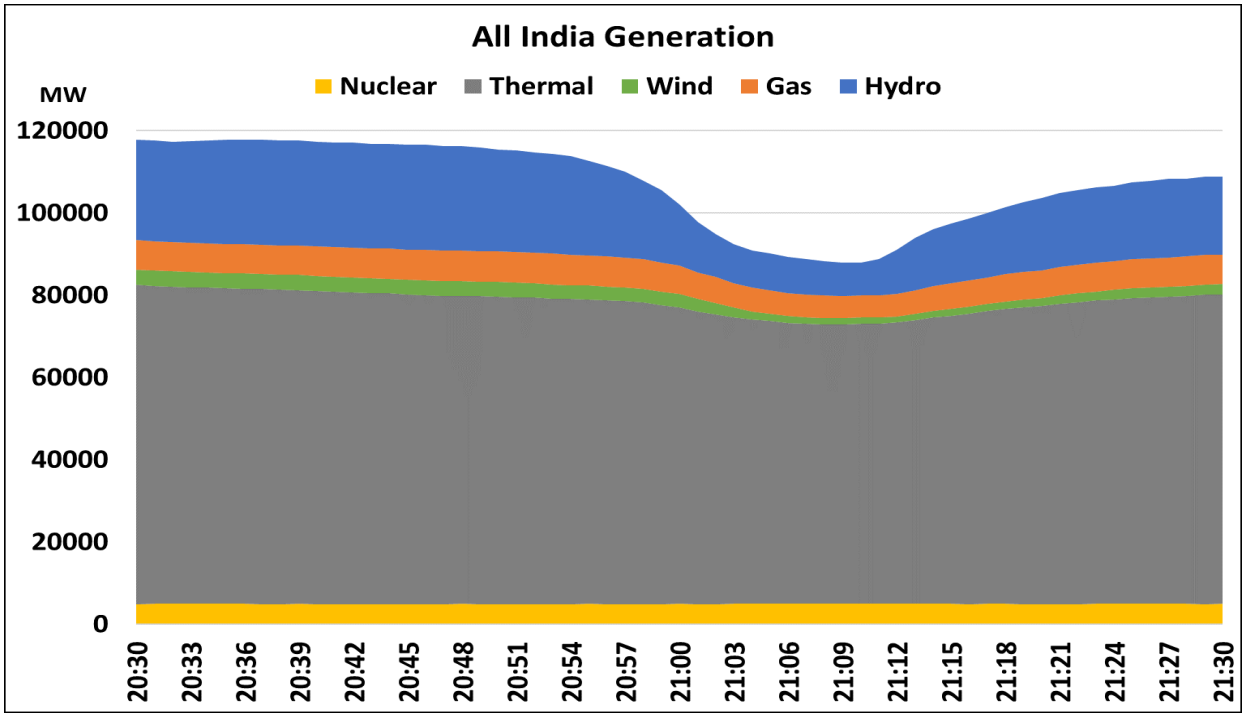
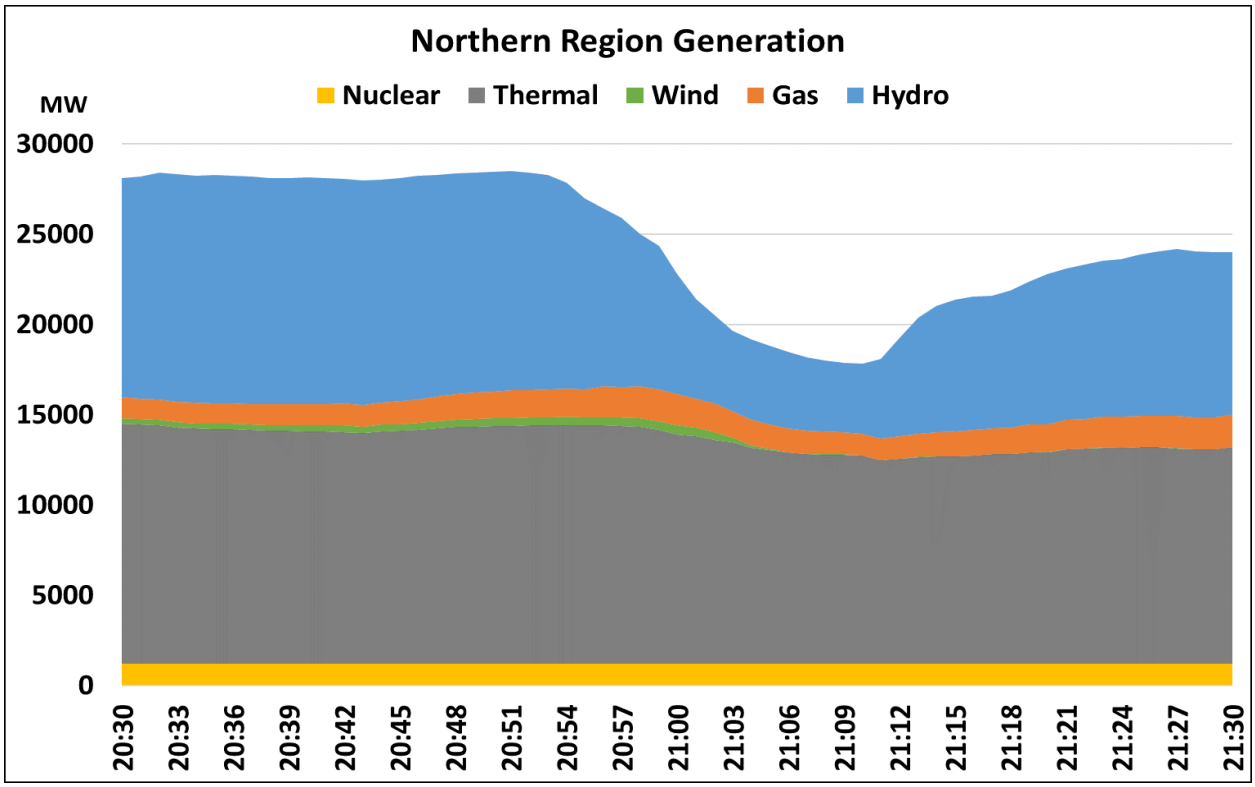
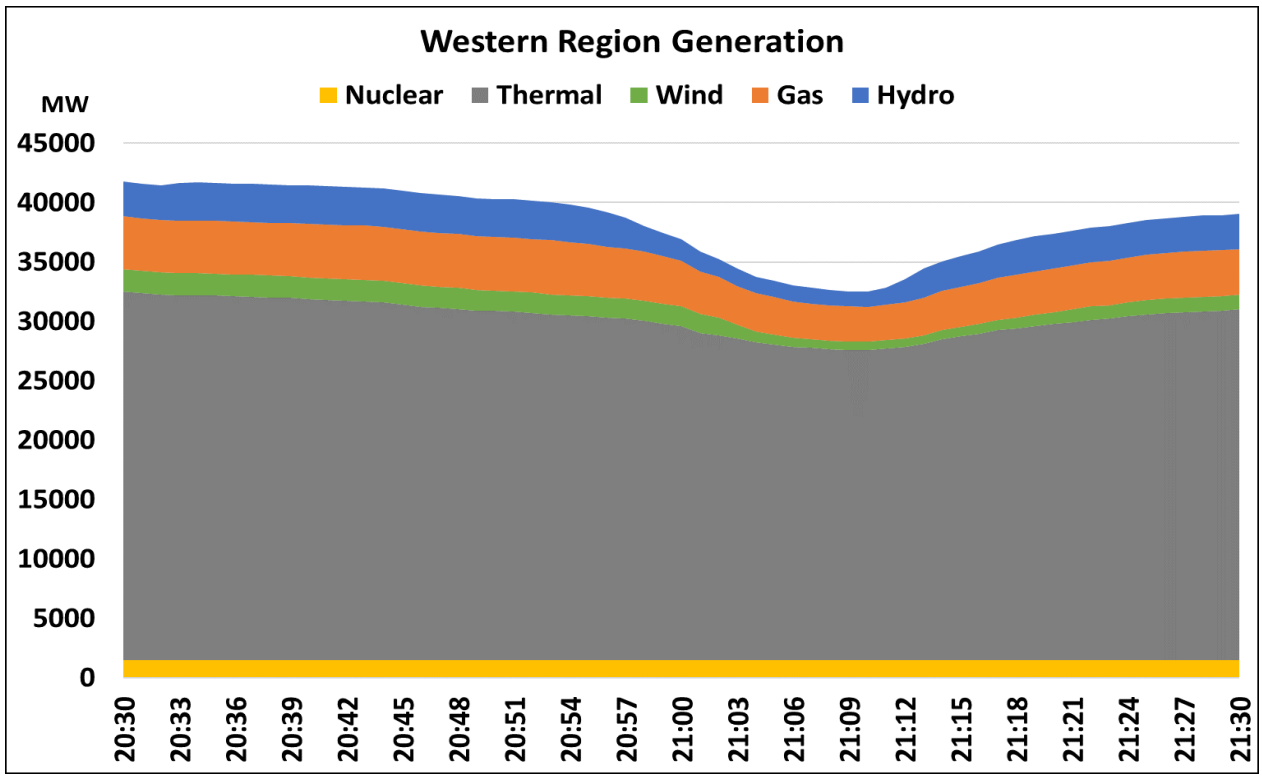
Annexure 7.1 Regional and State Generation Patterns






Western Region Generation
Nuclear
Thermal
Wind
Gas
Hydro
MW
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
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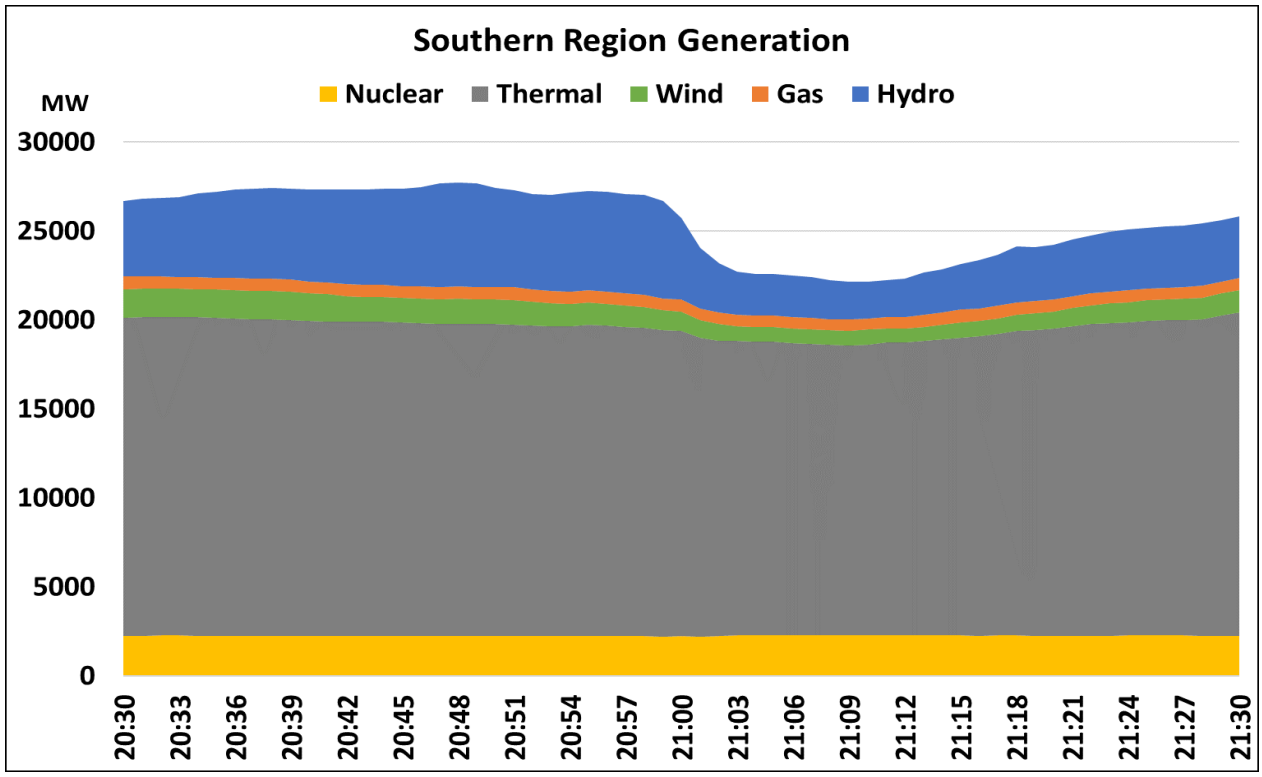
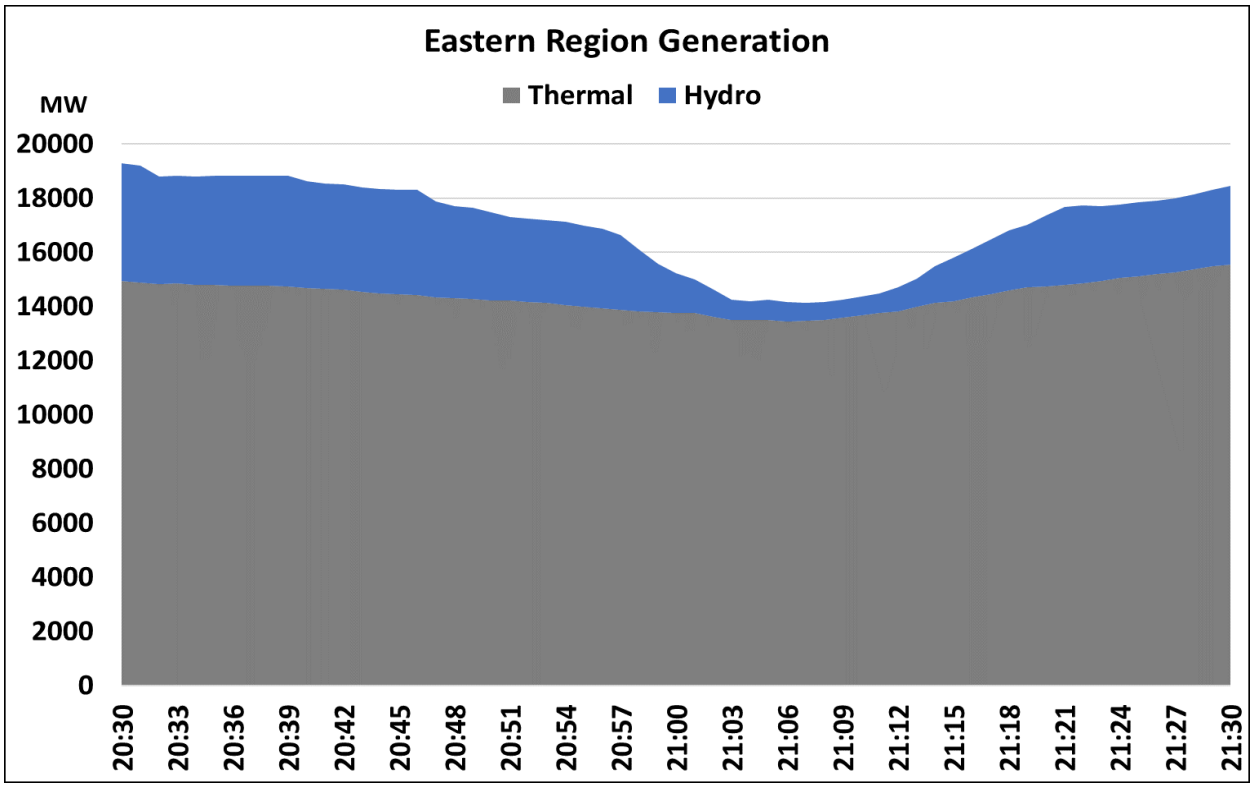
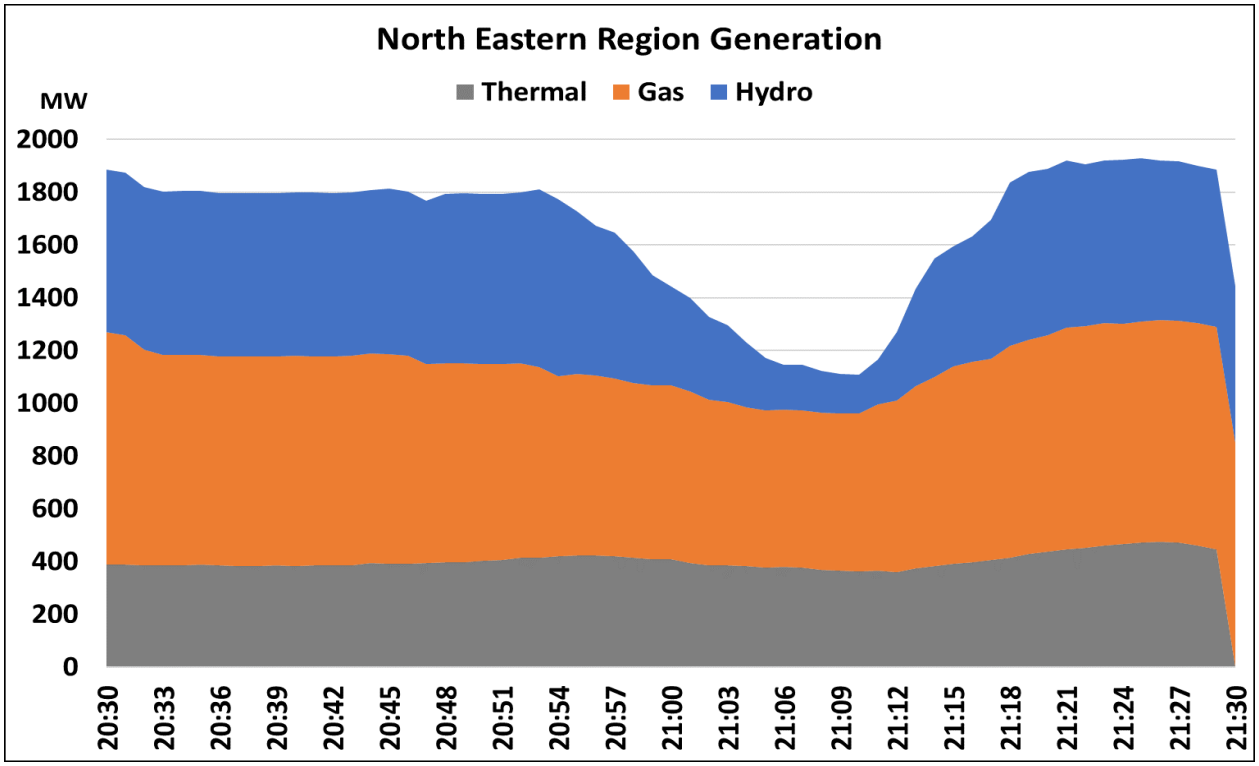
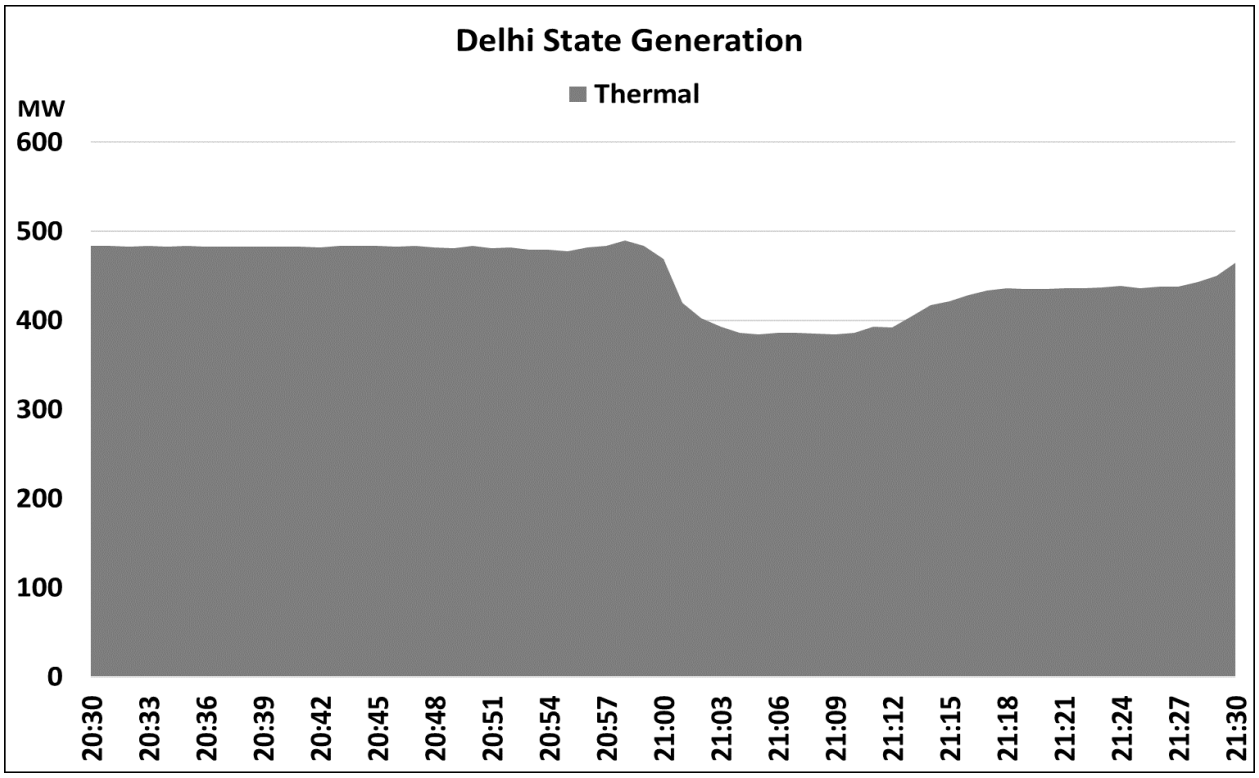
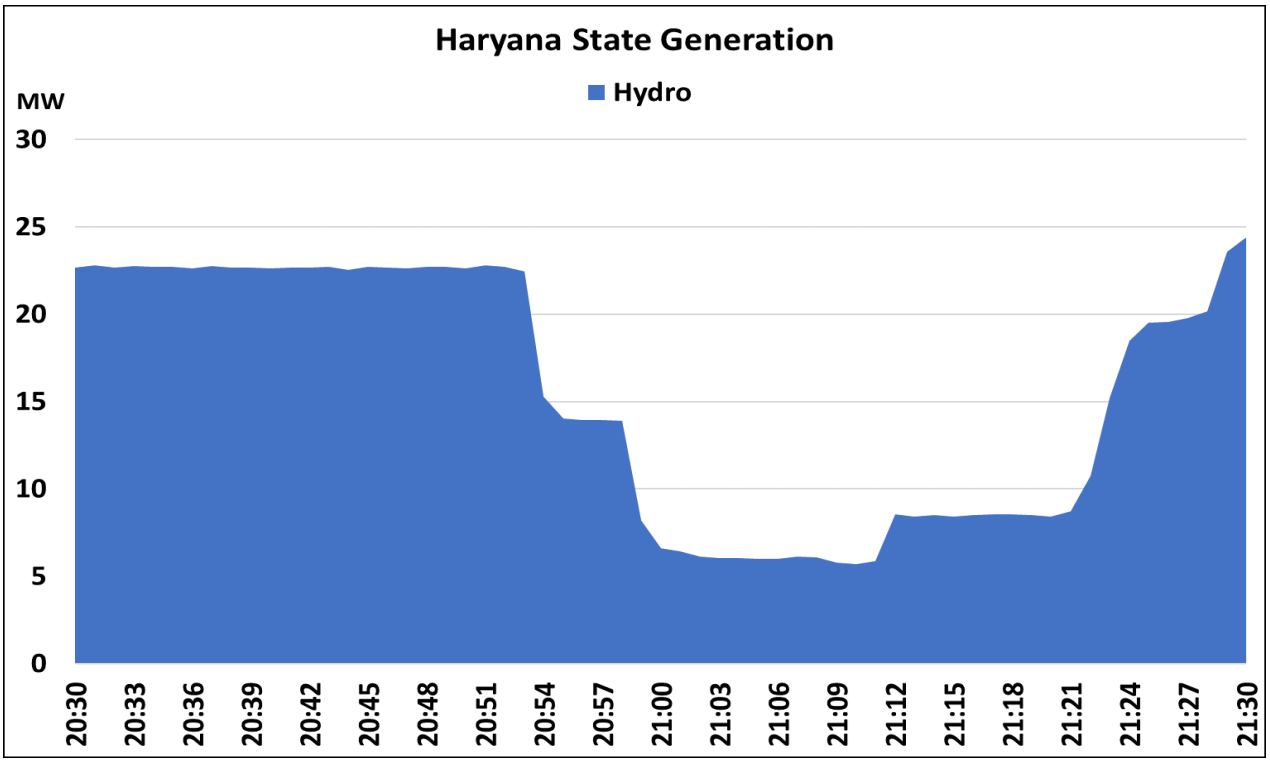
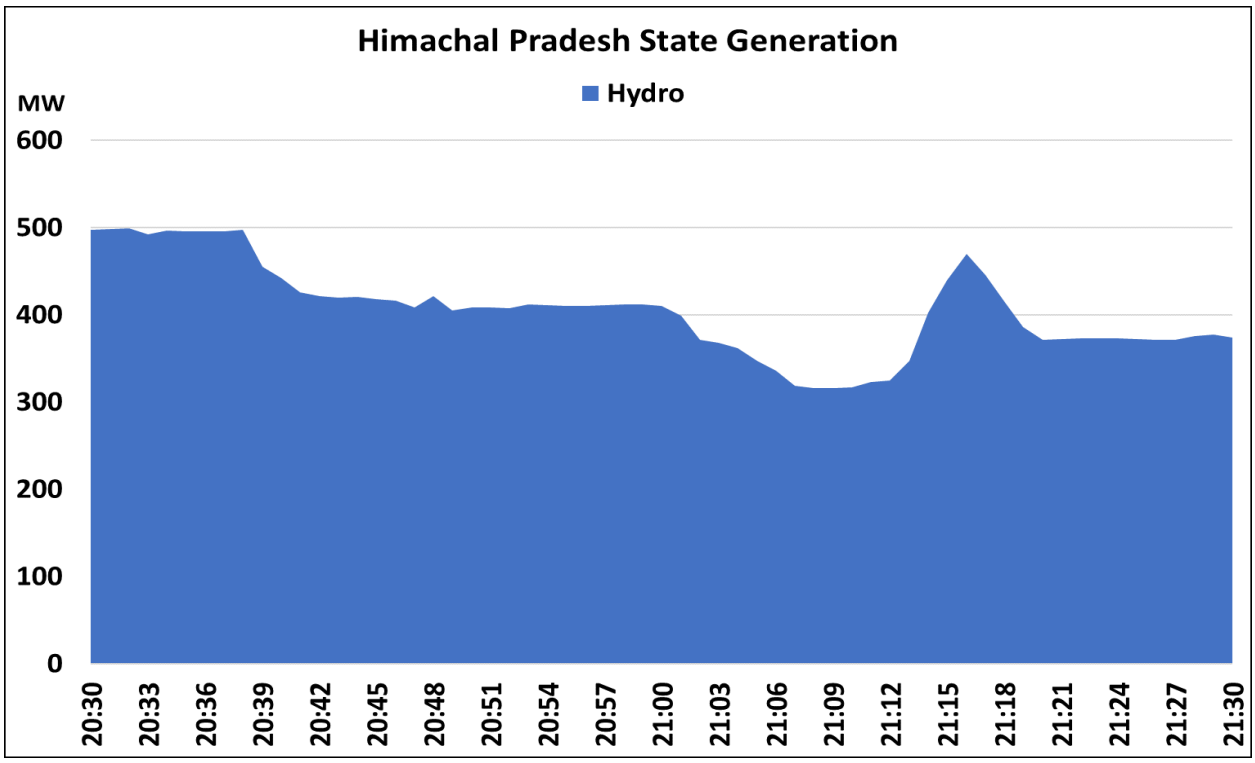

Southern Region Generation
Nuclear
Thermal
Wind
Gas
Hydro
MW
30000
25000
20000
15000
10000
5000
0
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30

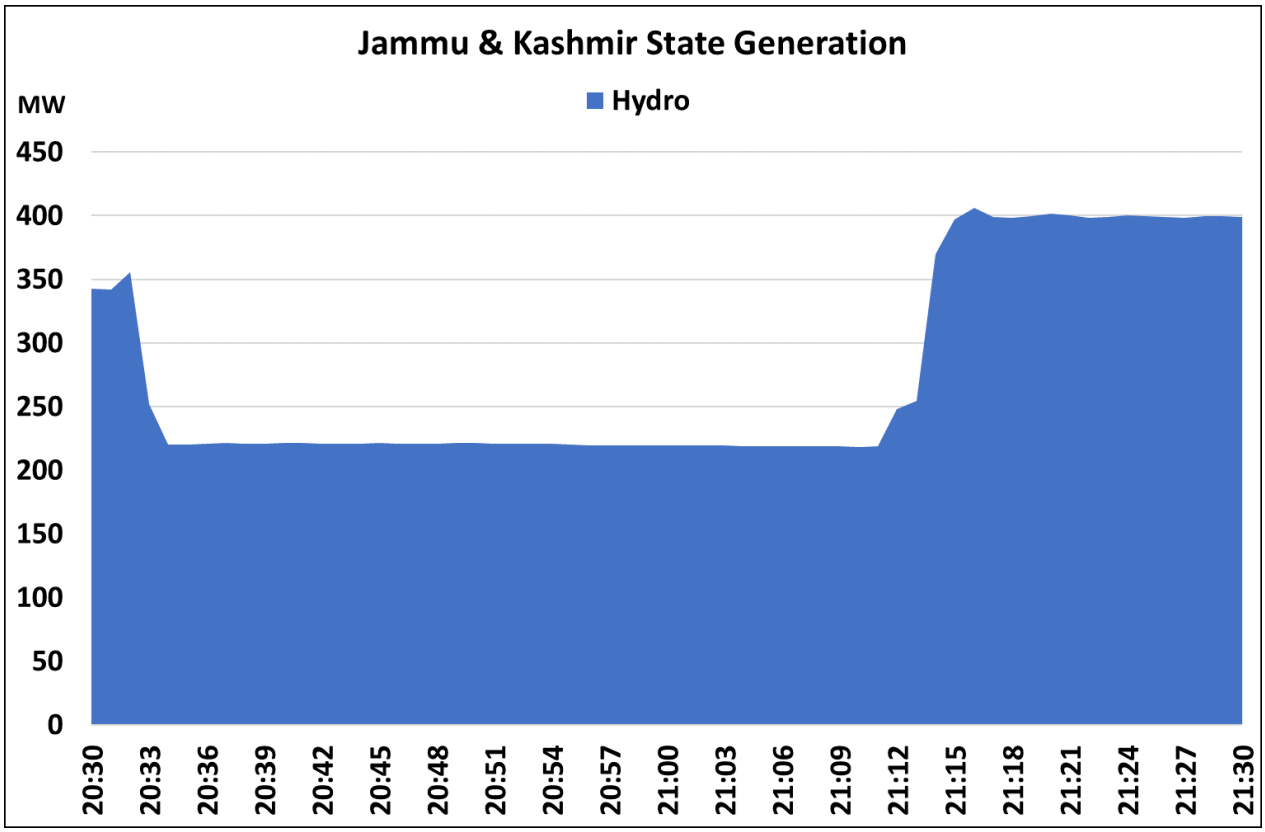

Eastern Region Generation
Thermal
Hydro
MW
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30

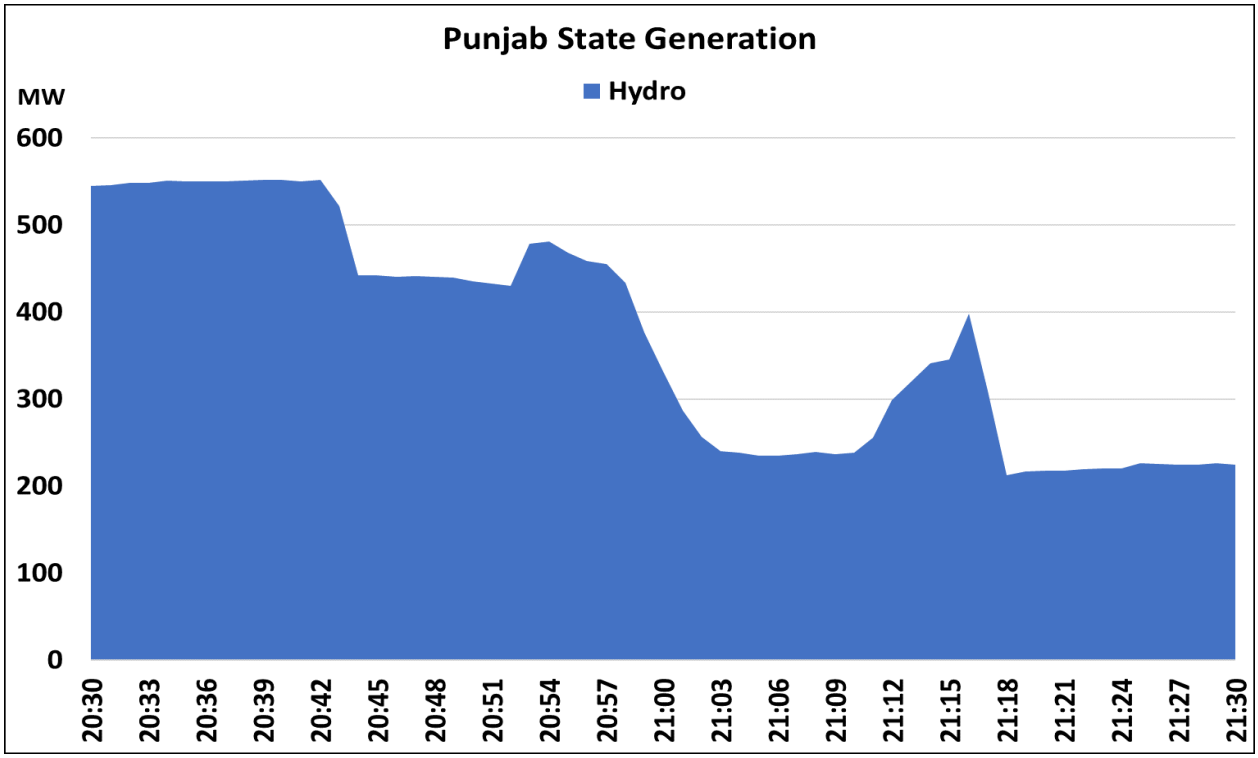

North Eastern Region Generation
Thermal
Gas
Hydro
MW
2000
1800
1600
1400
1200
1000
800
600
400
200
0
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30

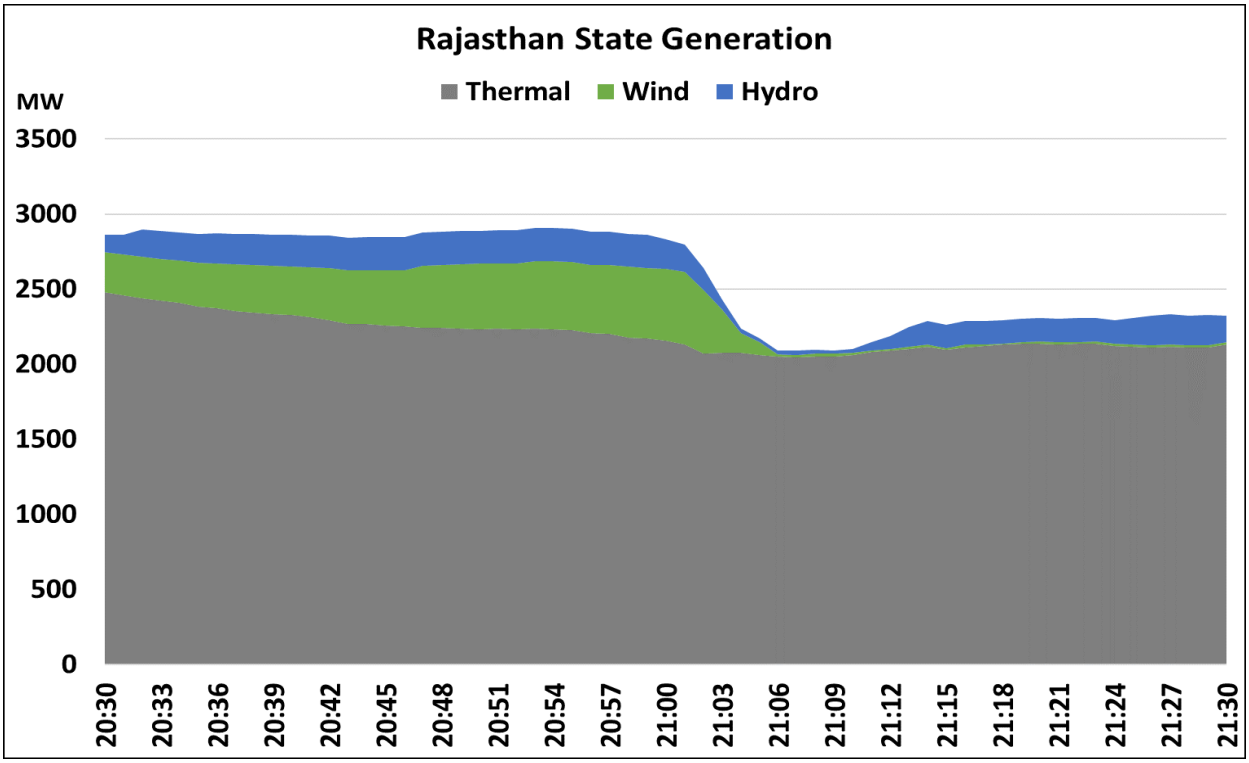

Delhi State Generation
Thermal
MW
600
500
400
300
200
100
0
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30

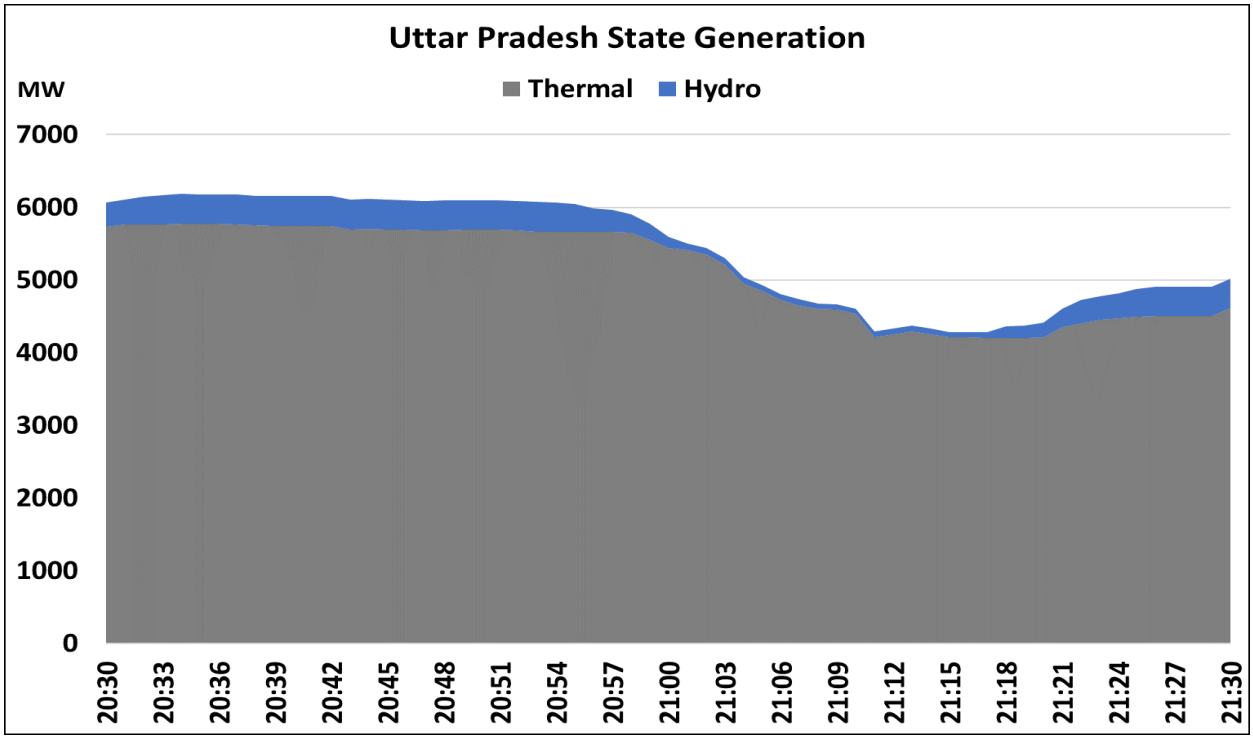

Haryana State Generation
Hydro
MW
30
25
20
15
10
5
0
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30

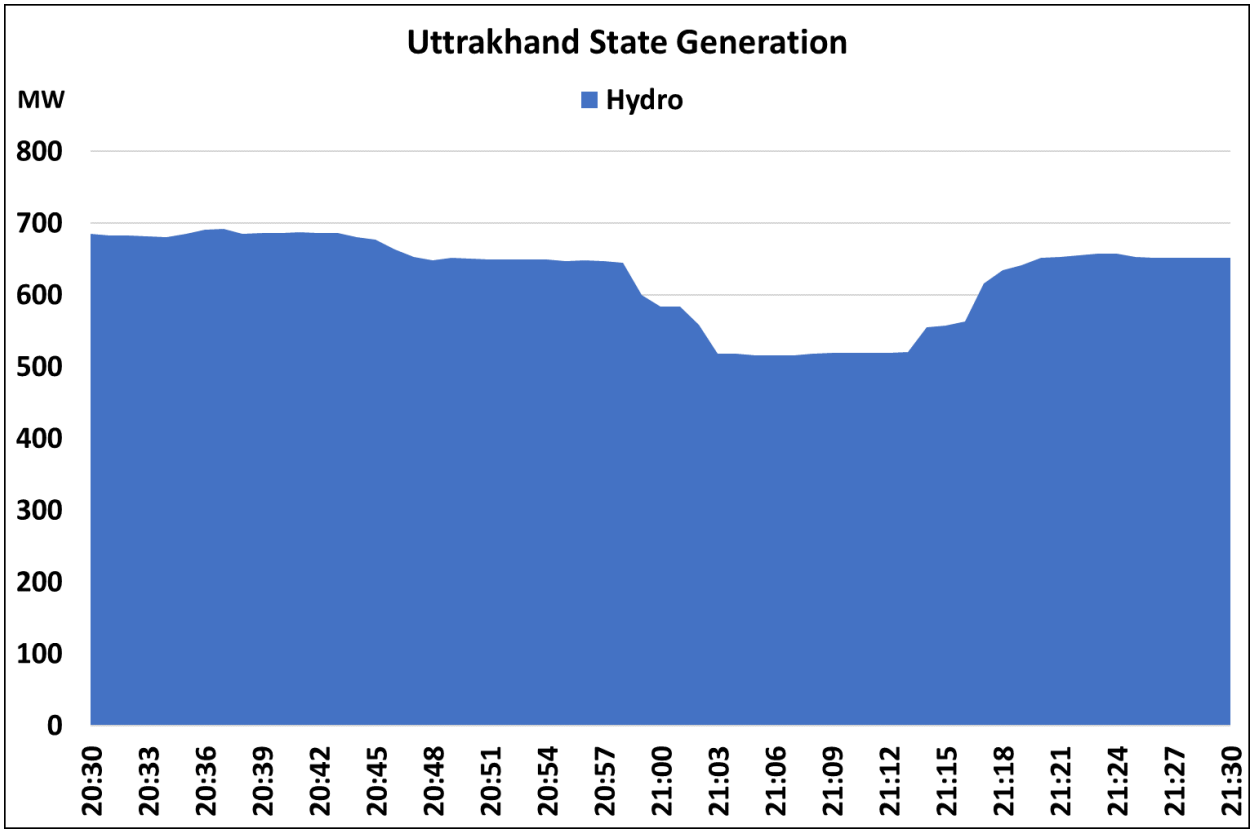

Himachal Pradesh State Generation
Hydro
MW
600
500
400
300
200
100
0
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30

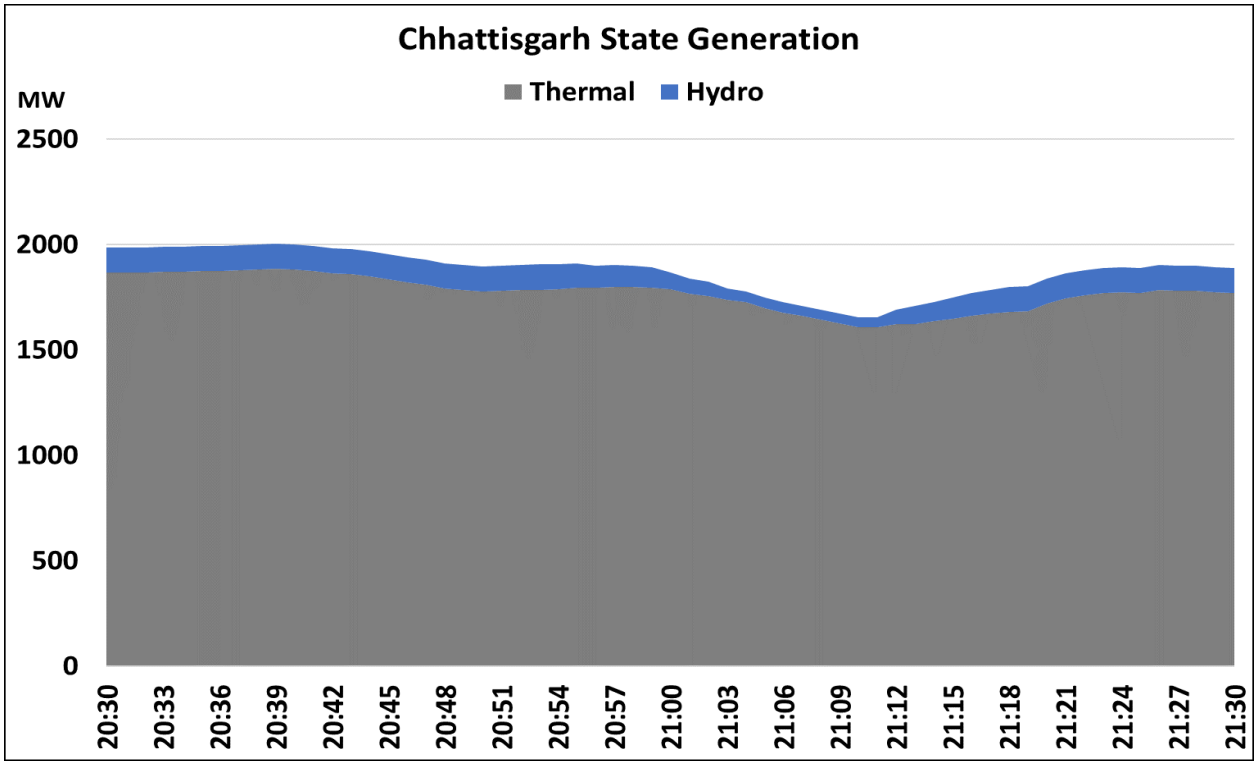

Jammu & Kashmir State Generation
Hydro
MW
450
400
350
300
250
200
150
100
50
0
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30

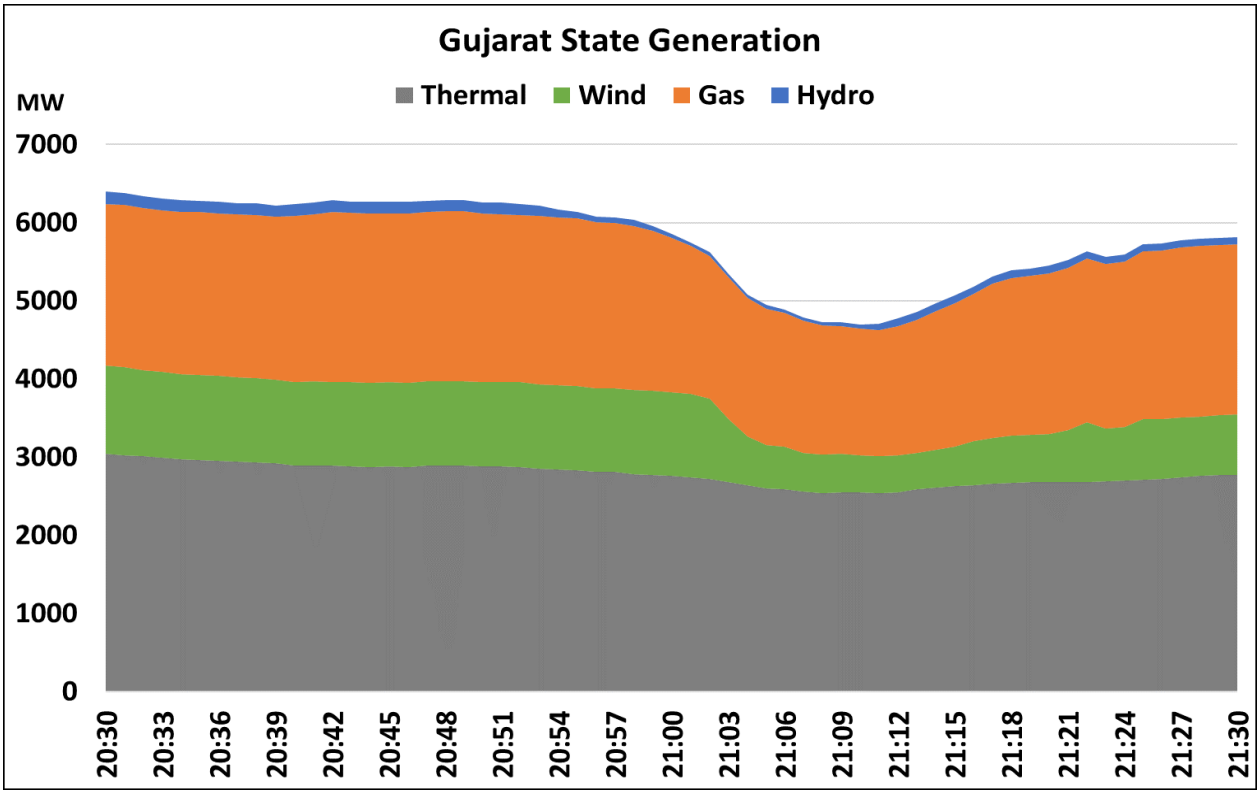

Punjab State Generation
Hydro
MW
600
500
400
300
200
100
0
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30

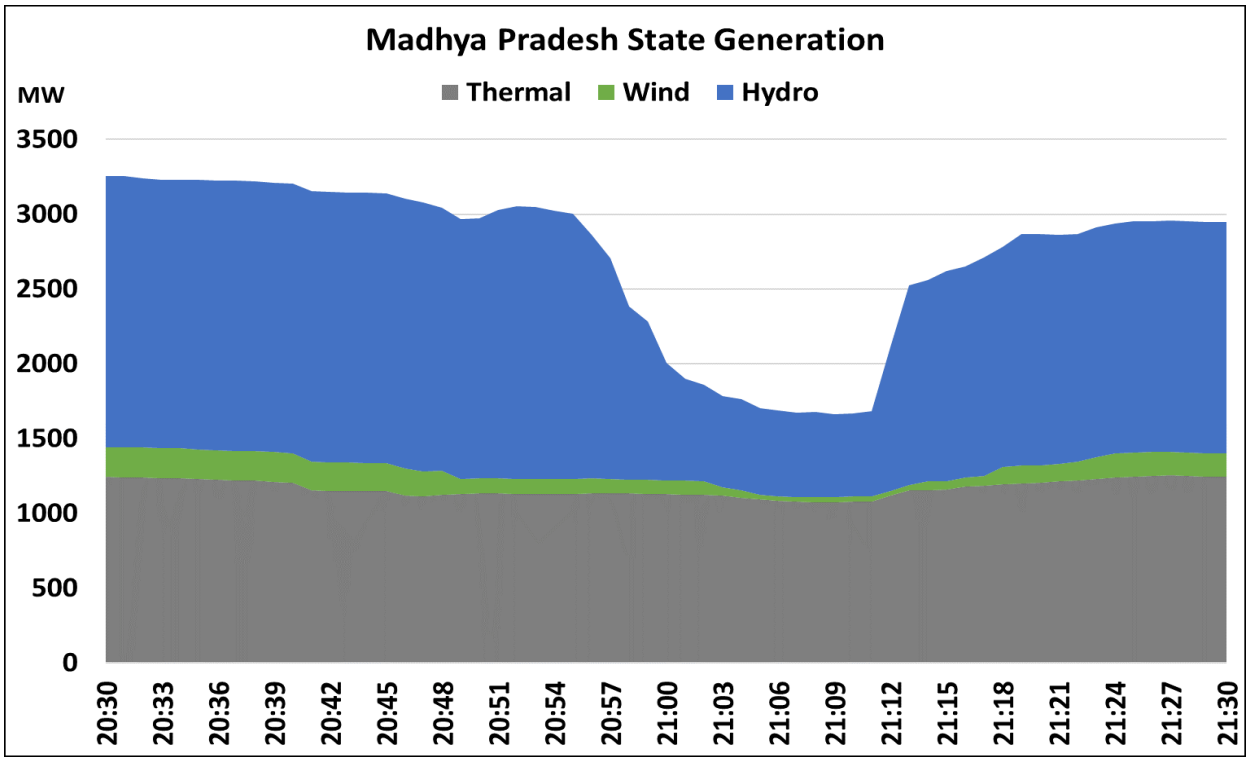

Rajasthan State Generation
Thermal
Wind
Hydro
MW
3500
3000
2500
2000
1500
1000
500
0
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30

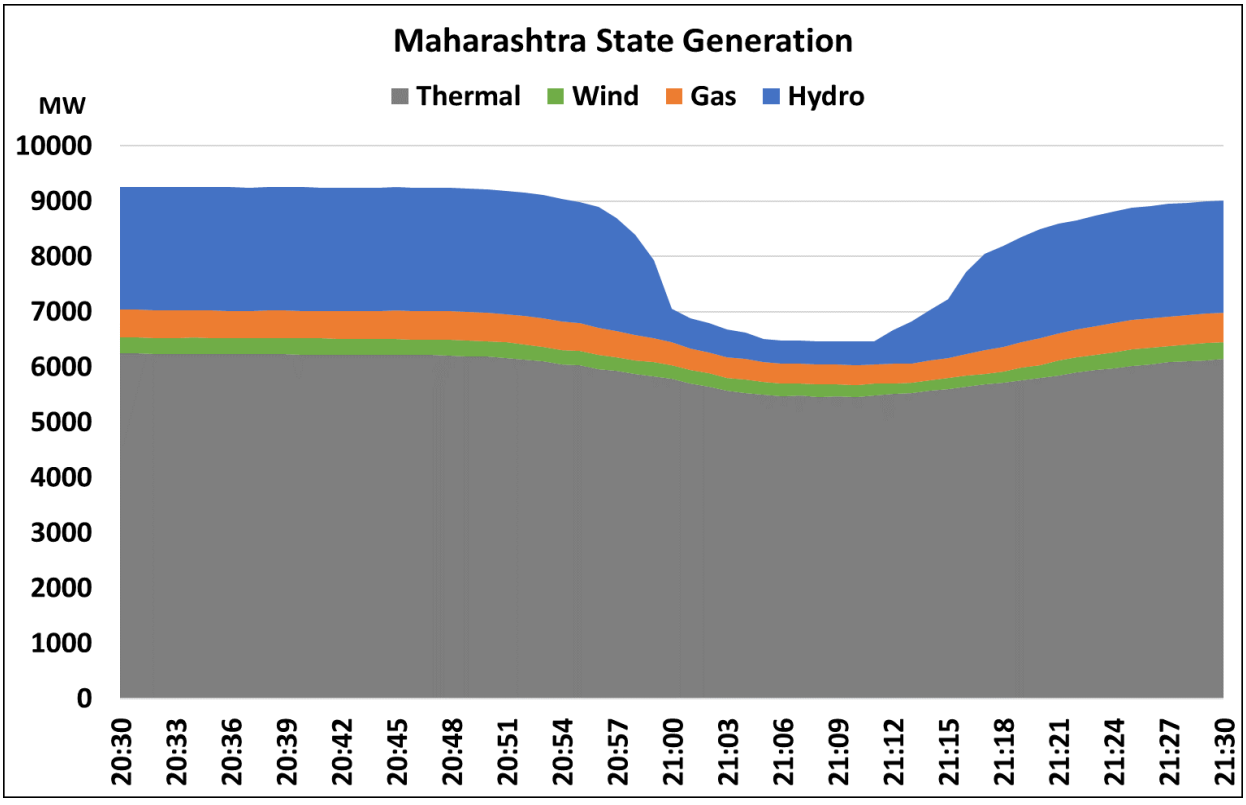

Uttar Pradesh State Generation
MW
Thermal
Hydro
7000
6000
5000
4000
3000
2000
1000
0
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30

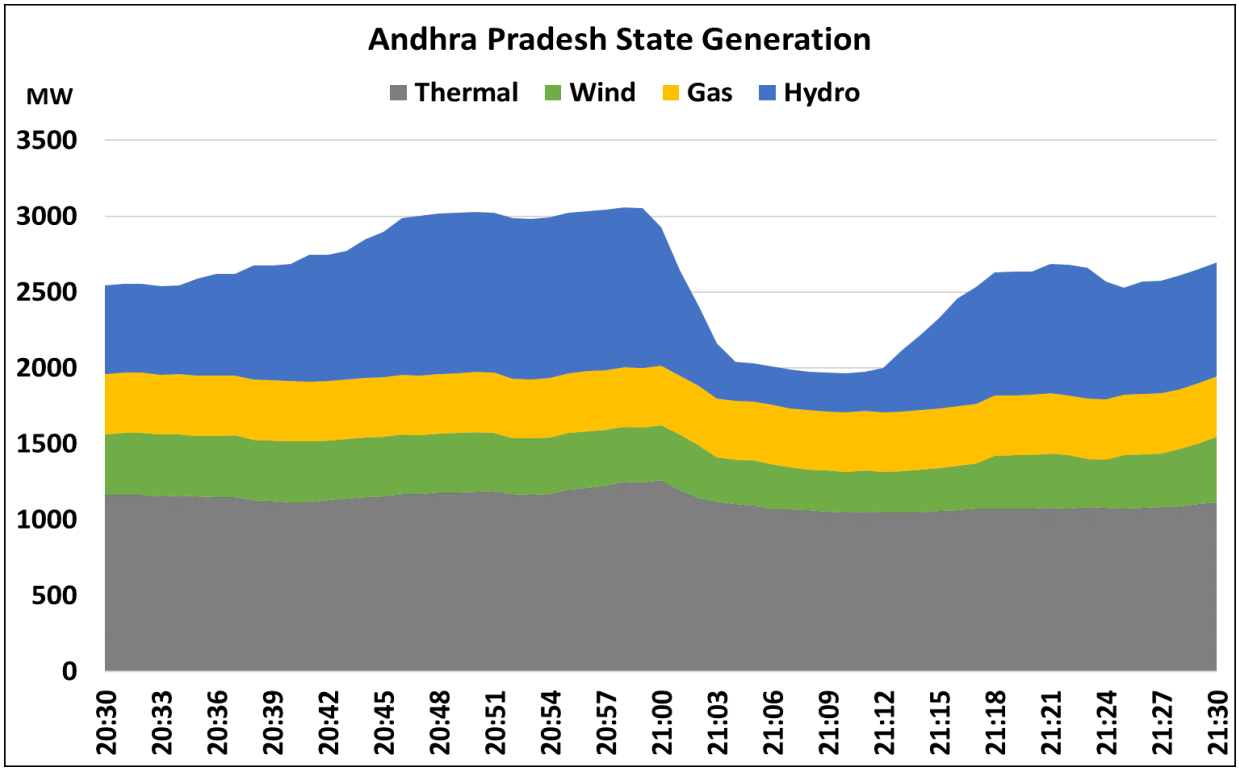

Uttrakhand State Generation
MW
Hydro
800
700
600
500
400
300
200
100
0
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30

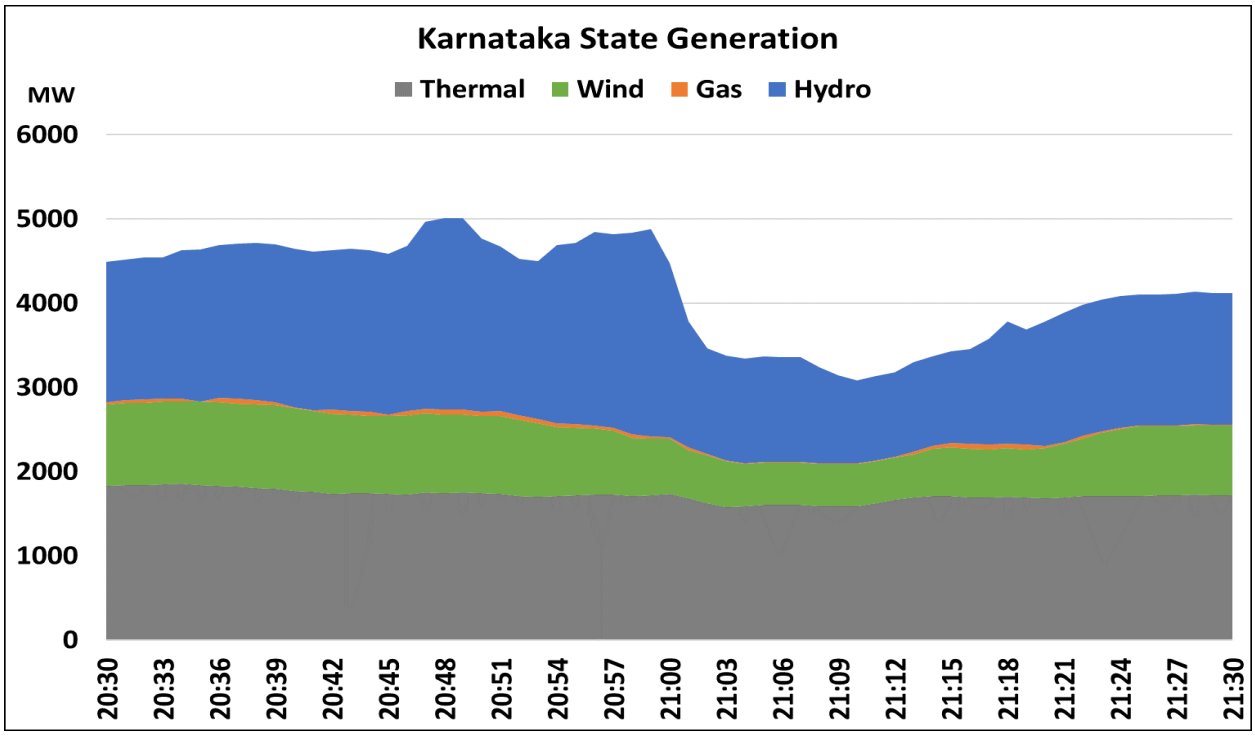

Chhattisgarh State Generation
Thermal
Hydro
MW
2500
2000
1500
1000
500
0
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30

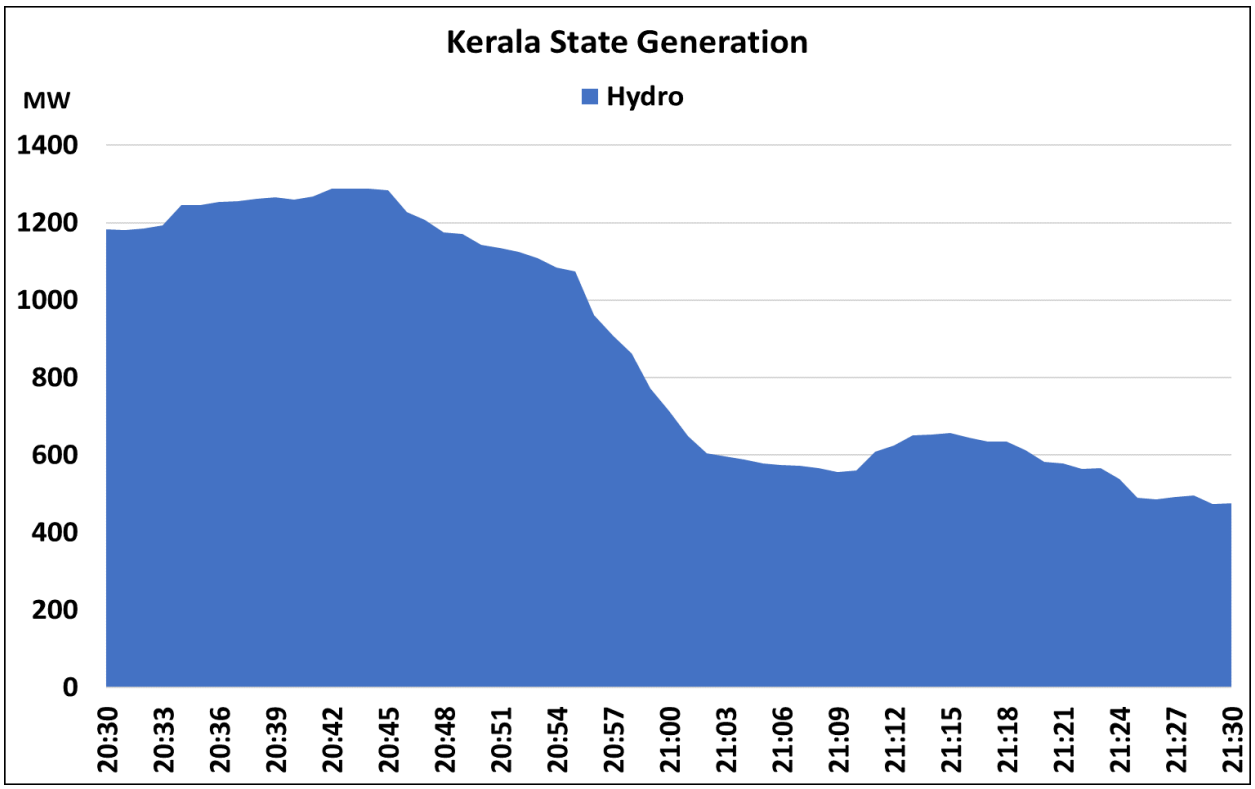

Gujarat State Generation
Thermal
Wind
Gas
Hydro
MW
7000
6000
5000
4000
3000
2000
1000
0
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30

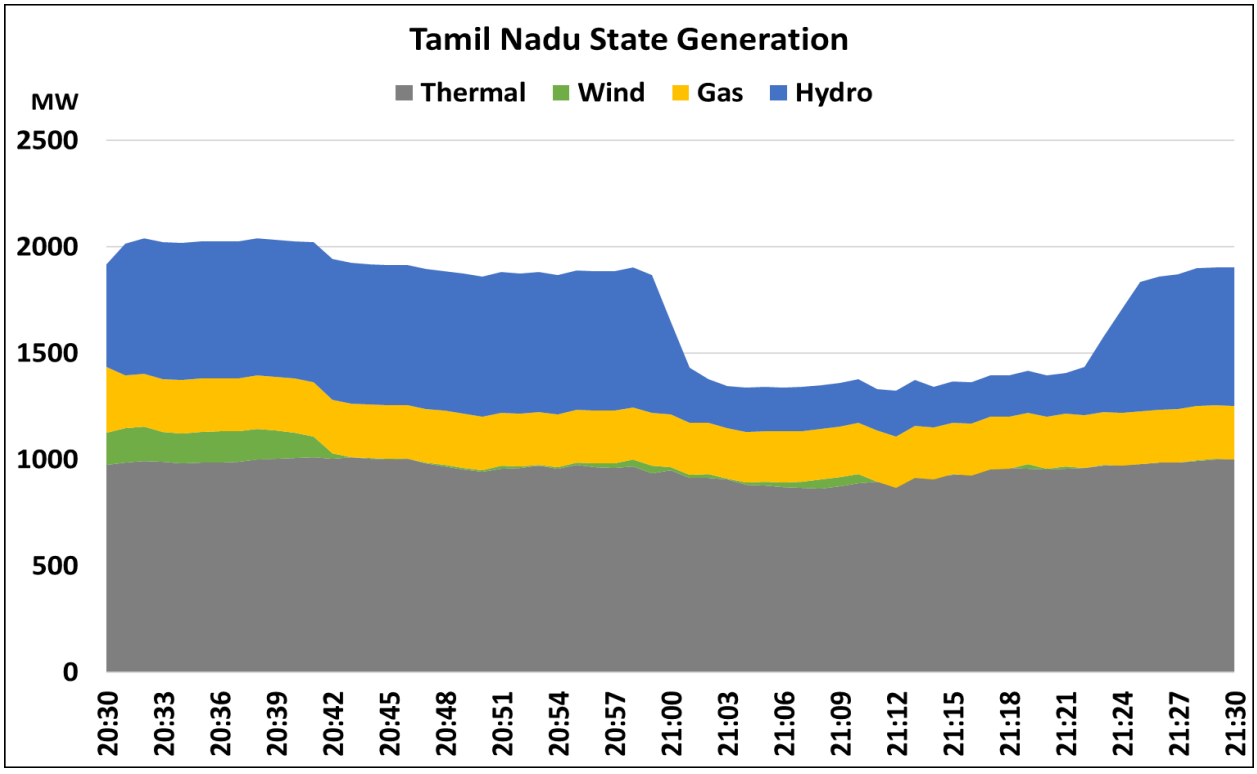

Madhya Pradesh State Generation
MW
Thermal
Wind
Hydro
3500
3000
2500
2000
1500
1000
500
0
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30

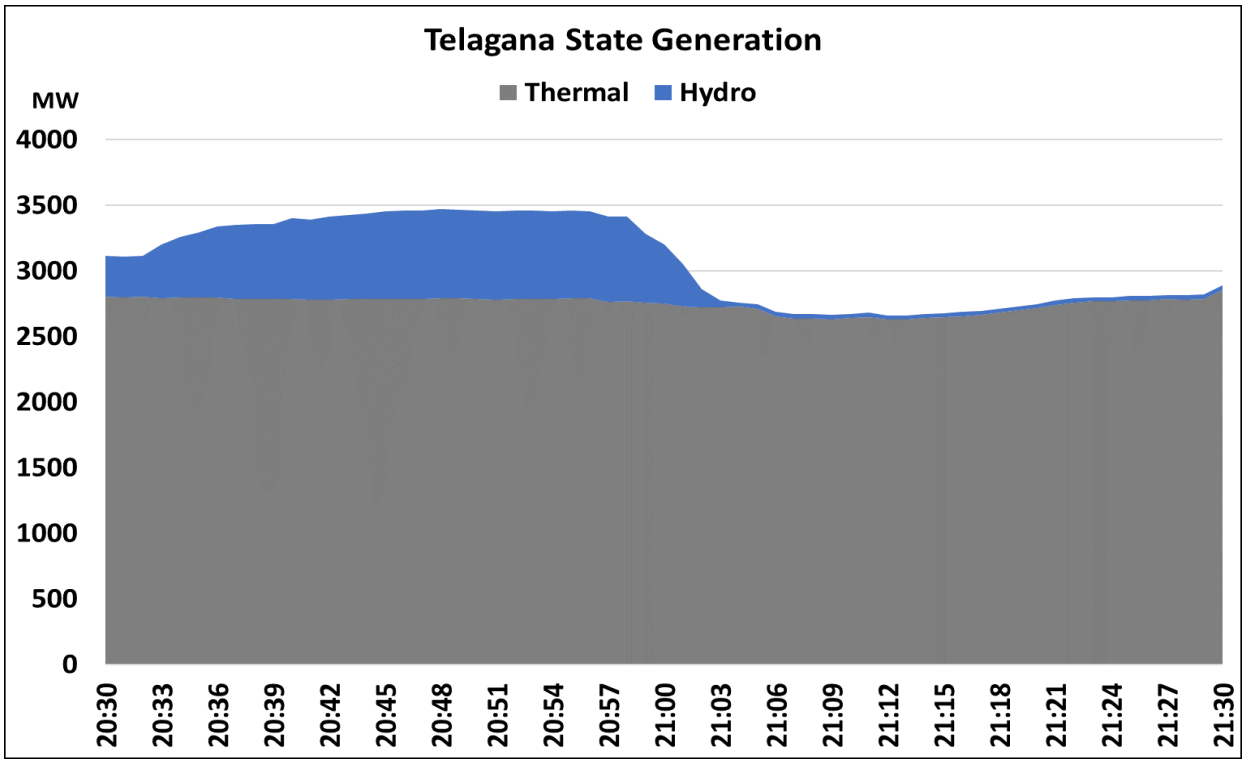

Maharashtra State Generation
MW
Thermal
Wind
Gas
Hydro
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30

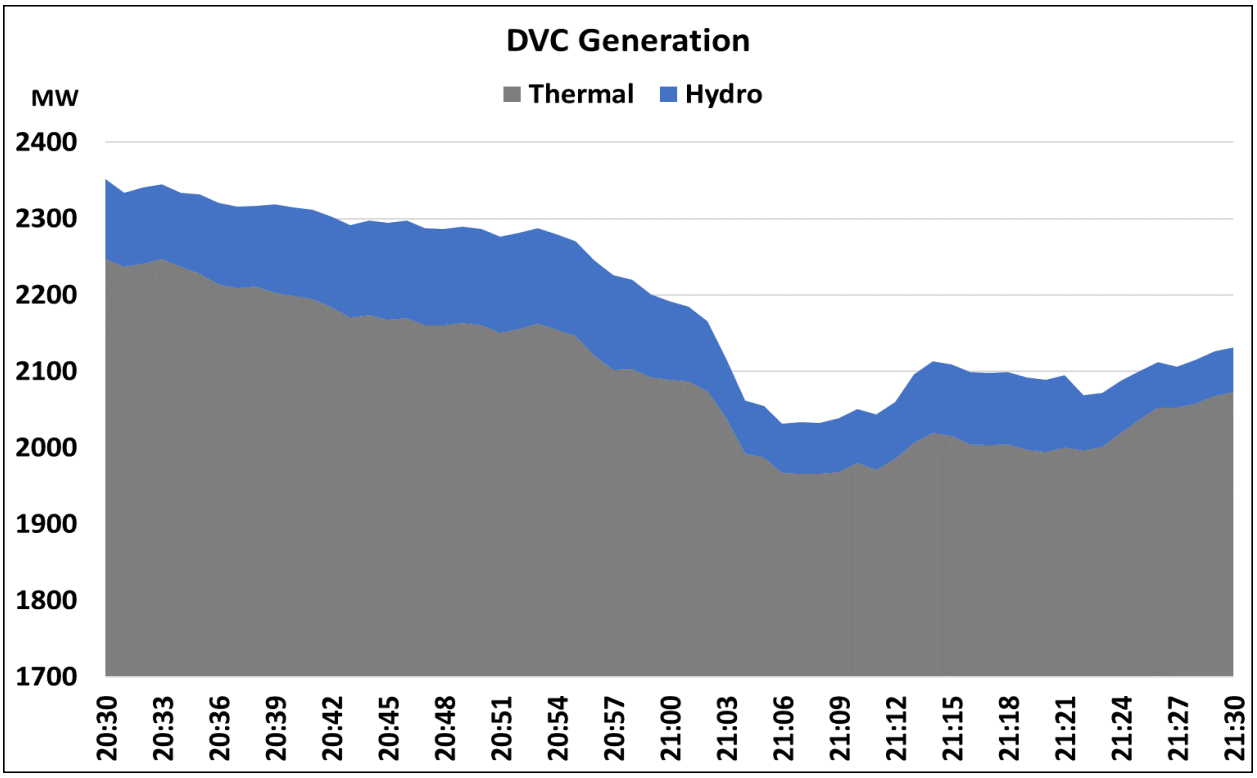

Andhra Pradesh State Generation
MW
Thermal
Wind
Gas
Hydro
3500
3000
2500
2000
1500
1000
500
0
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30

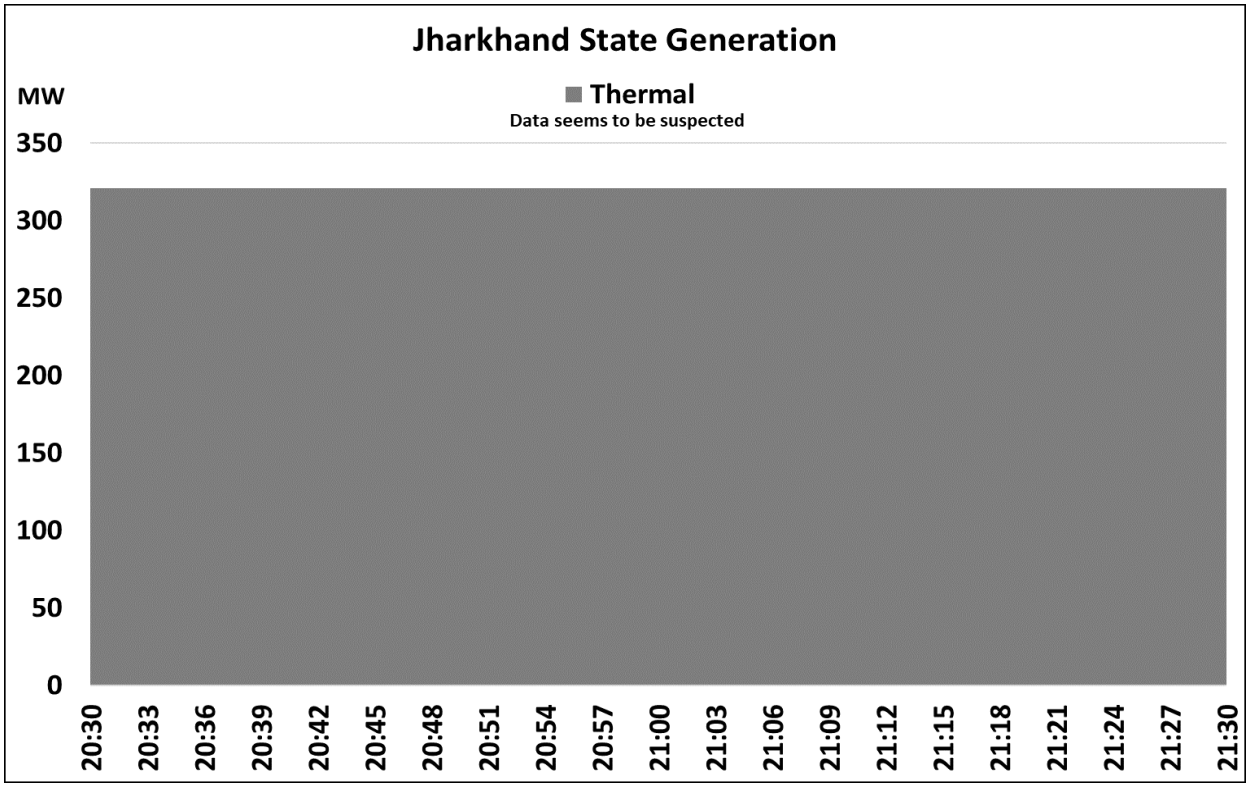

Karnataka State Generation
MW
Thermal
Wind
Gas
Hydro
6000
5000
4000
3000
2000
1000
0
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30

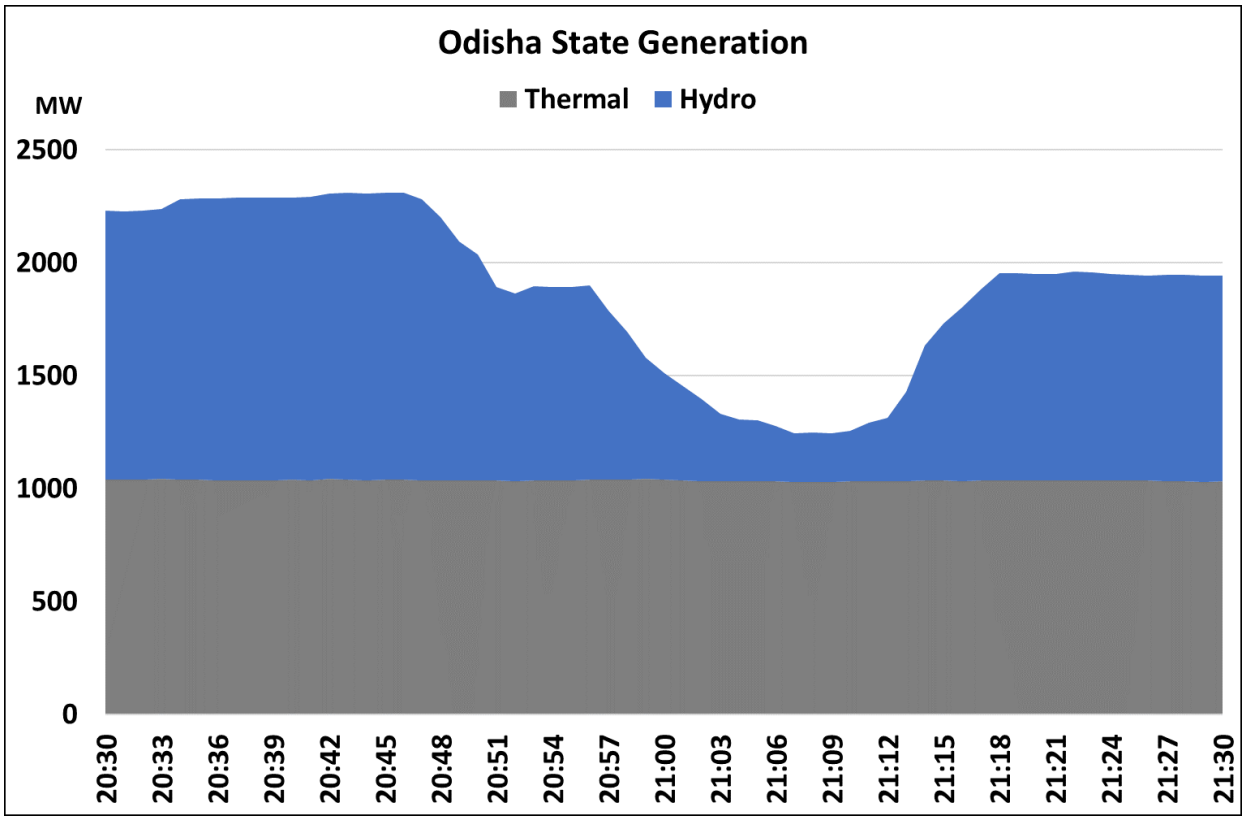

Kerala State Generation
Hydro
MW
1400
1200
1000
800
600
400
200
0
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30

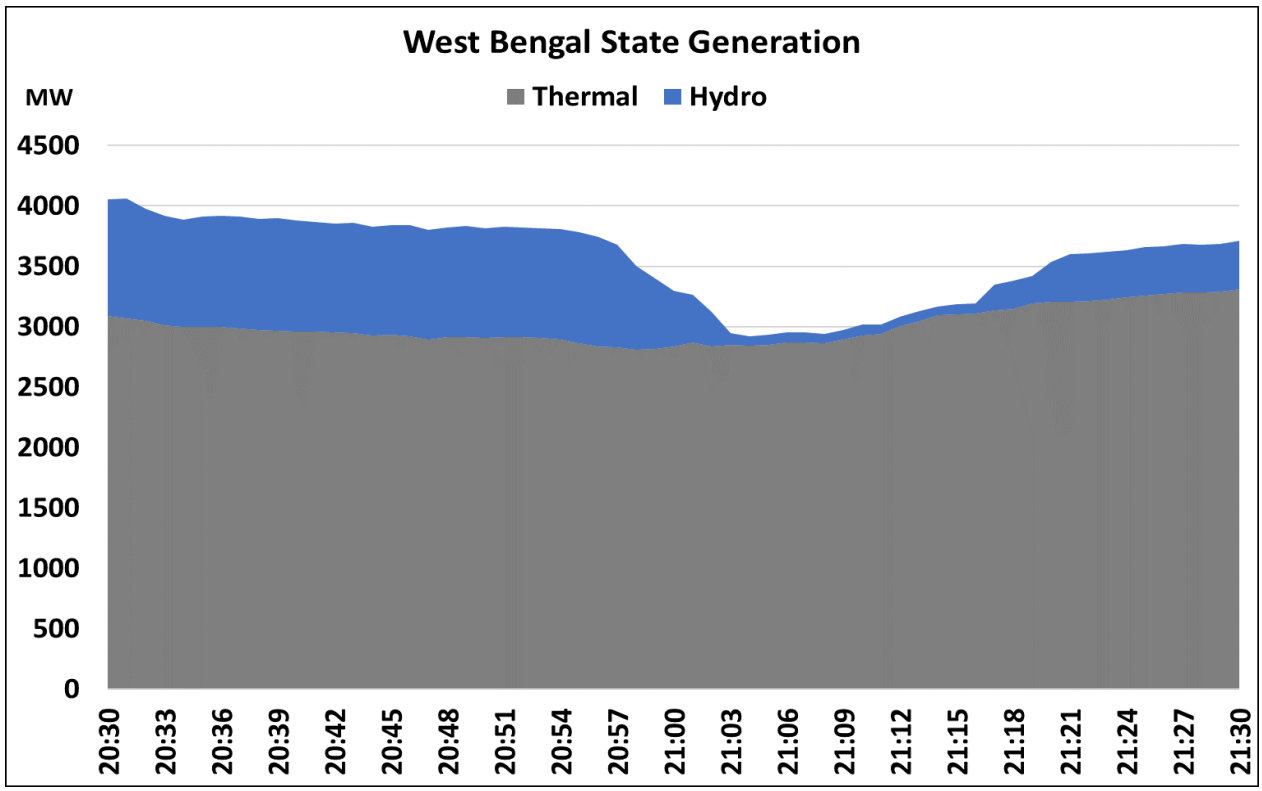

Tamil Nadu State Generation
Thermal
Wind
Gas
Hydro
MW
2500
2000
1500
1000
500
0
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30

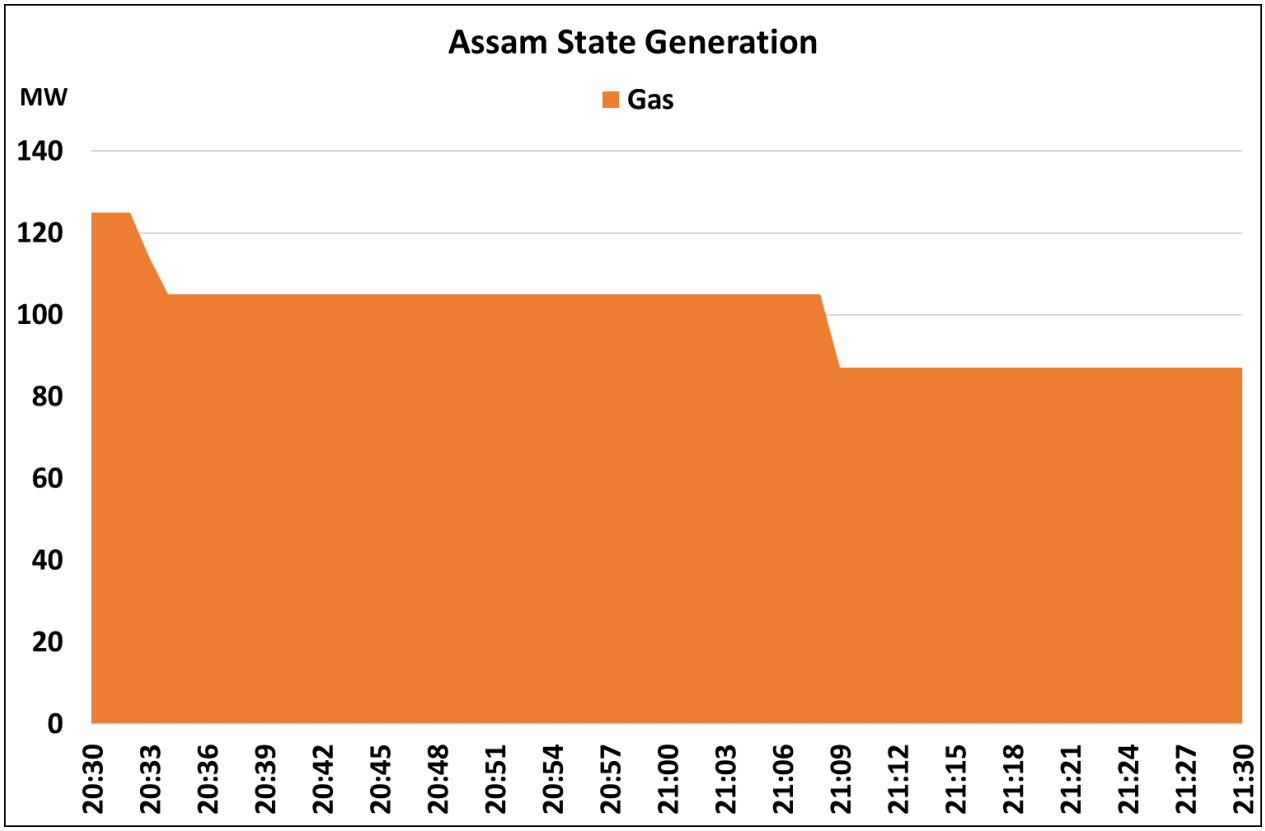

Telagana State Generation
Thermal
Hydro
MW
4000
3500
3000
2500
2000
1500
1000
500
0
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30

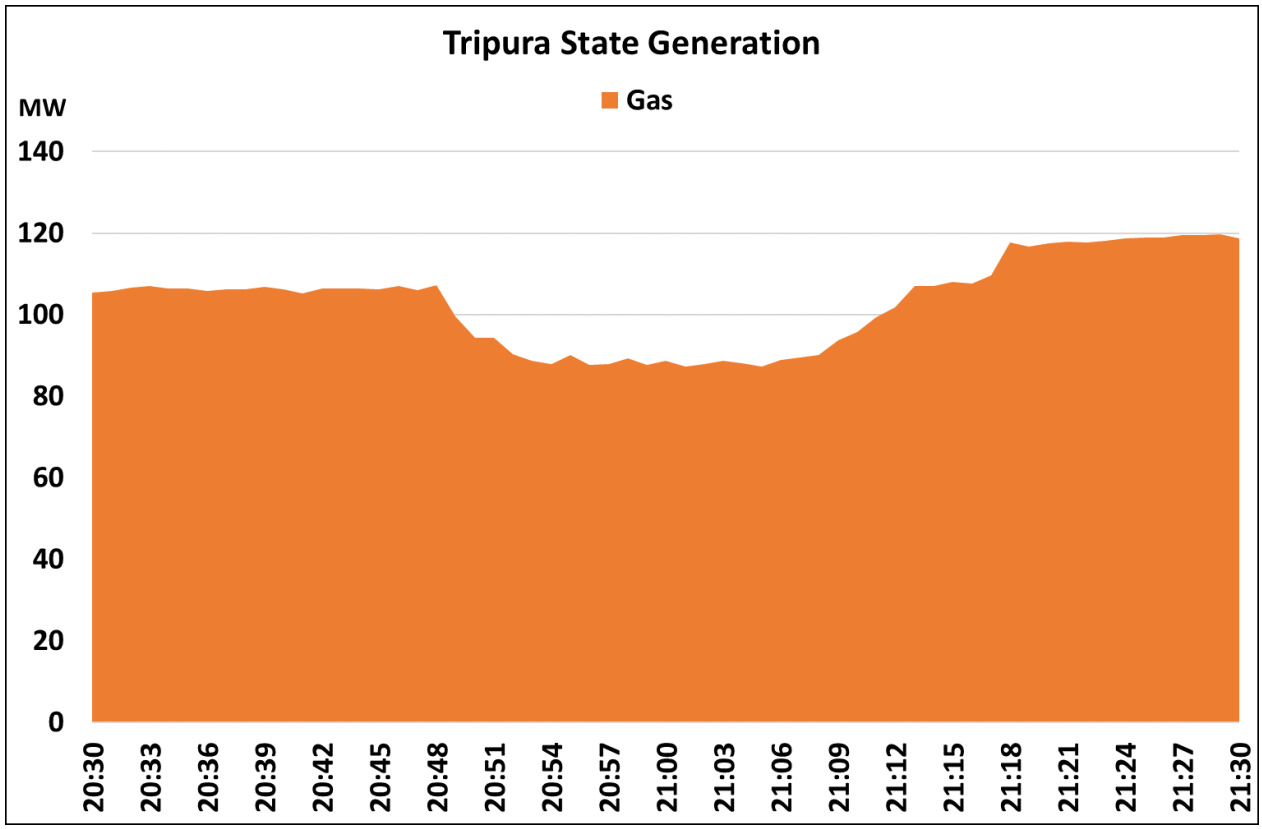

DVC Generation
Thermal
Hydro
MW
2400
2300
2200
2100
2000
1900
1800
1700
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30


Jharkhand State Generation
MW
Thermal
Data seems to be suspected
350
300
250
200
150
100
50
0
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30


Odisha State Generation
MW
Thermal
Hydro
2500
2000
1500
1000
500
0
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30


West Bengal State Generation
MW
Thermal
Hydro
4500
4000
3500
3000
2500
2000
1500
1000
500
0
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30


Assam State Generation
MW
Gas
140
120
100
80
60
40
20
0
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30


Tripura State Generation
Gas
MW
140
120
100
80
60
40
20
0
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
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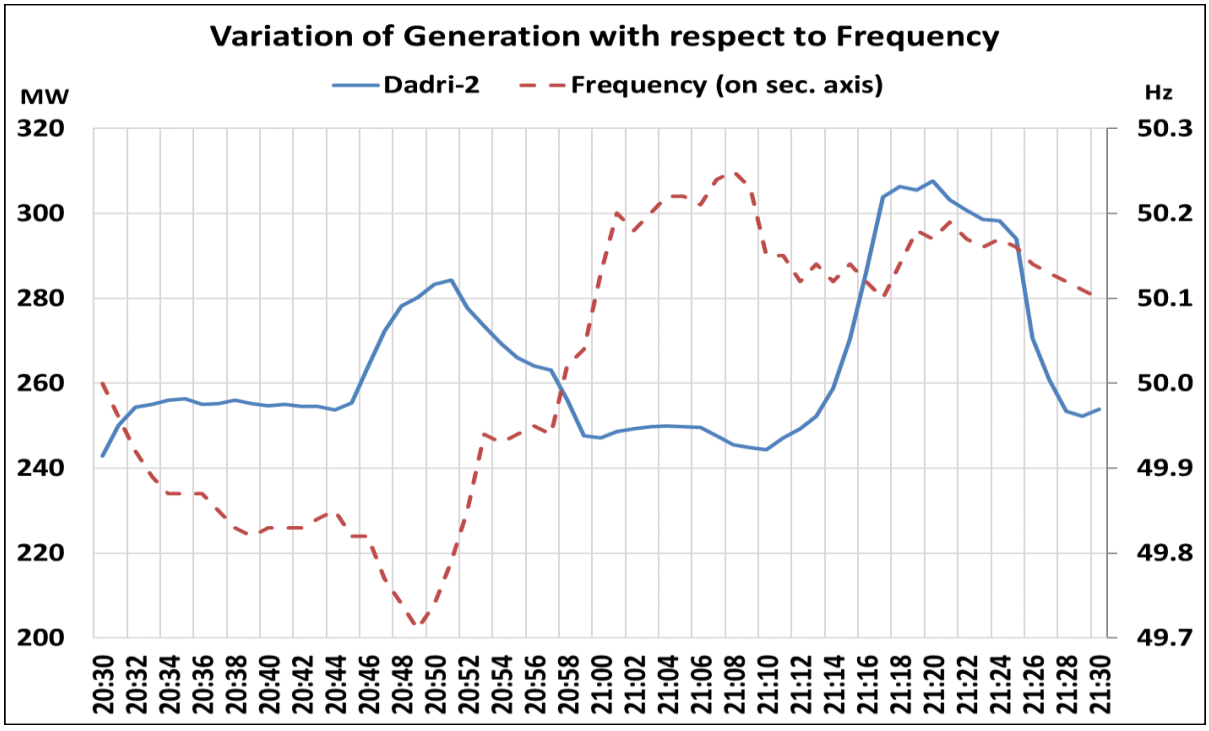
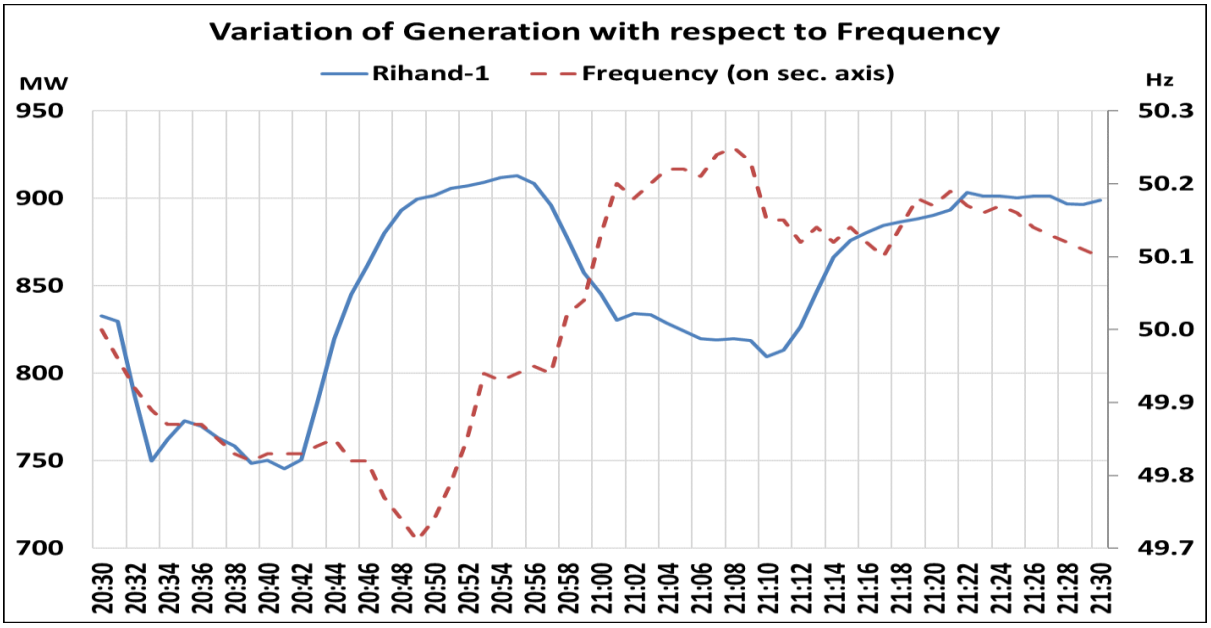
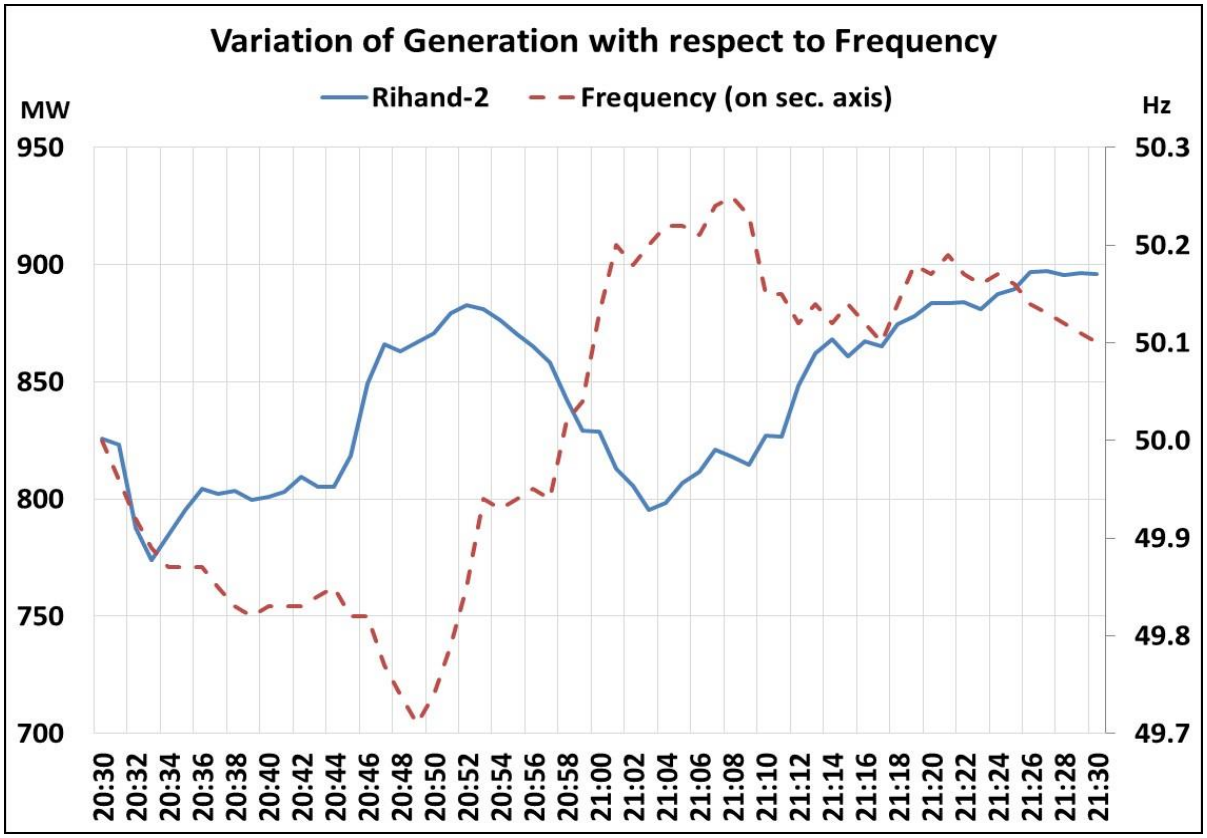
21:27
21:30

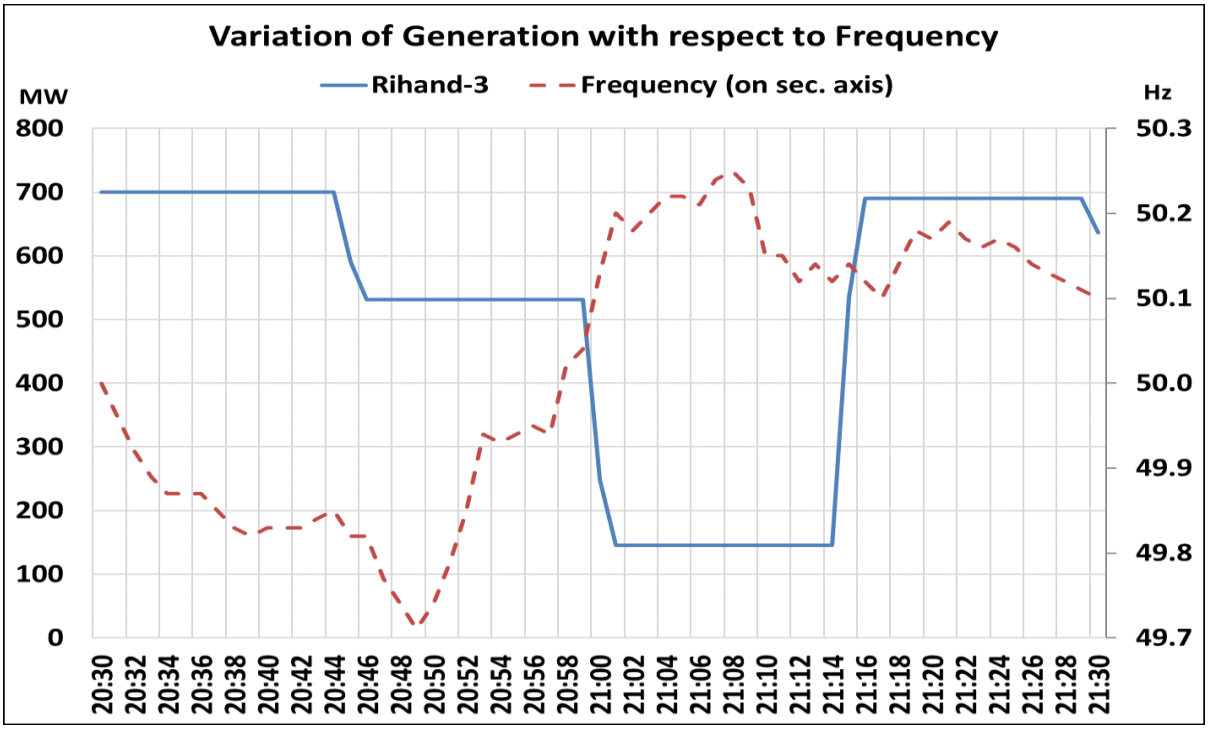
Annexure-7.2 Plant wise Thermal Generation Response

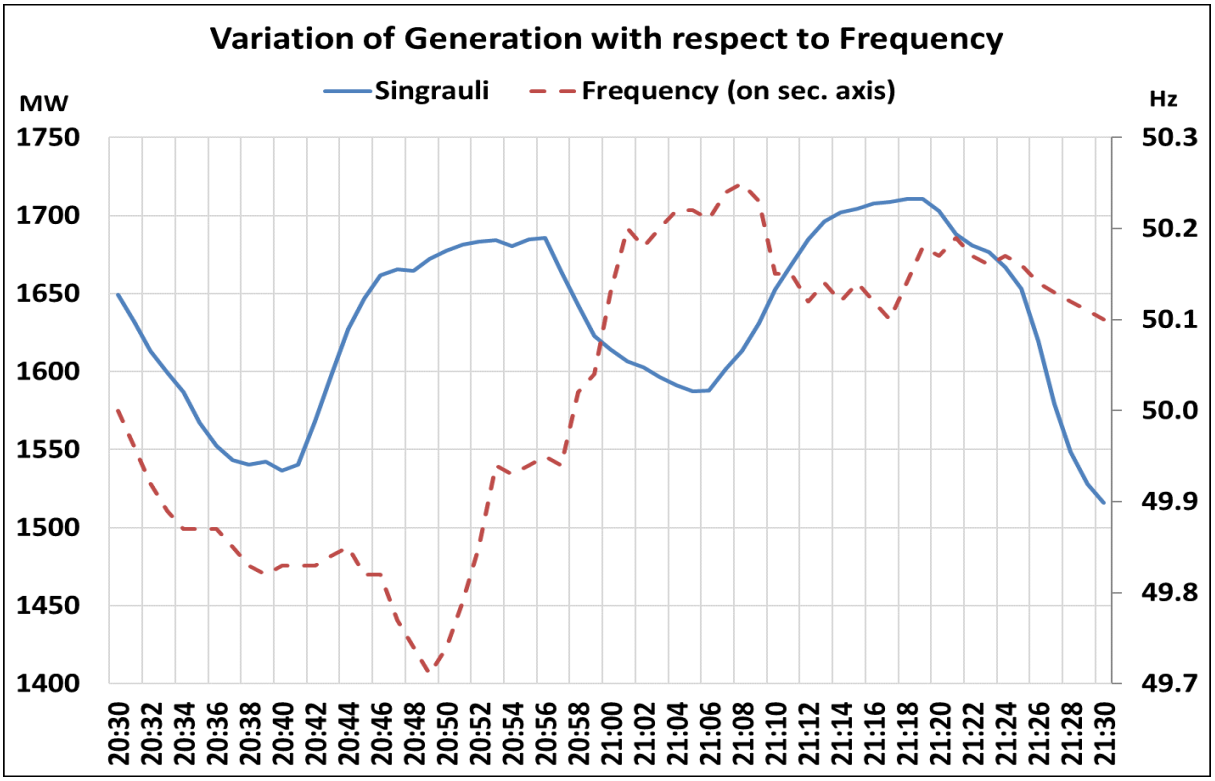
Northern Region

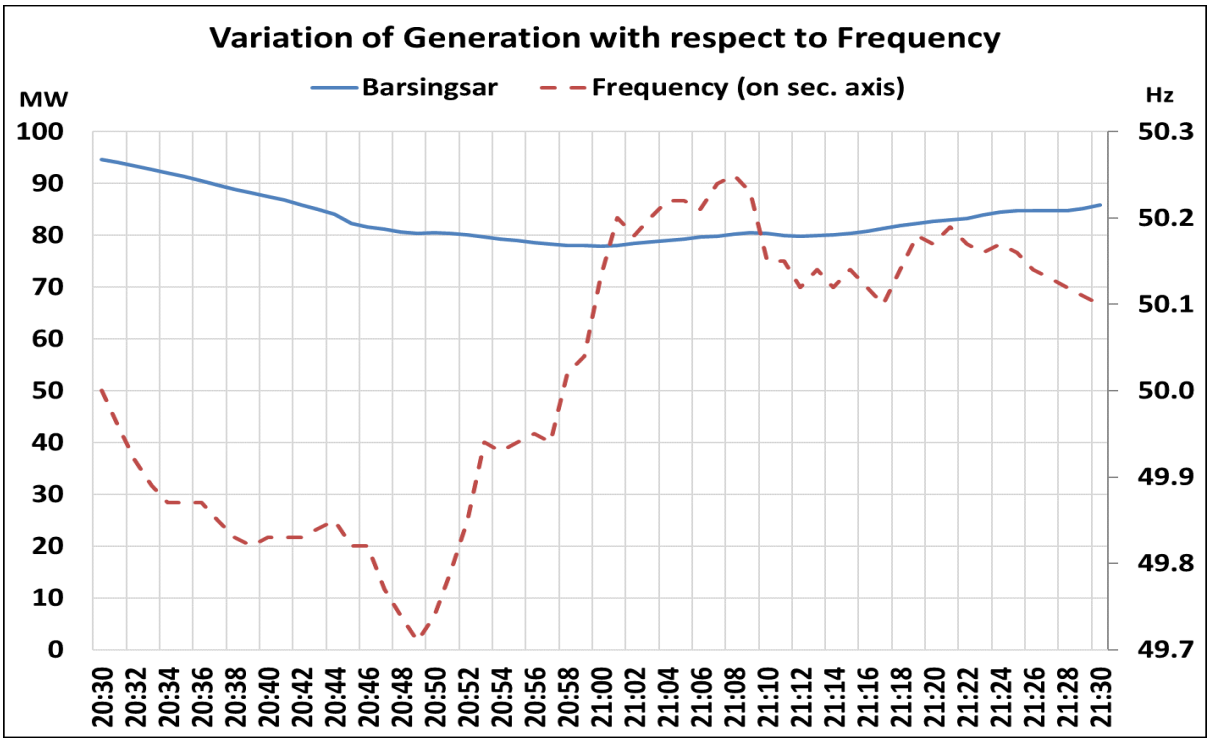


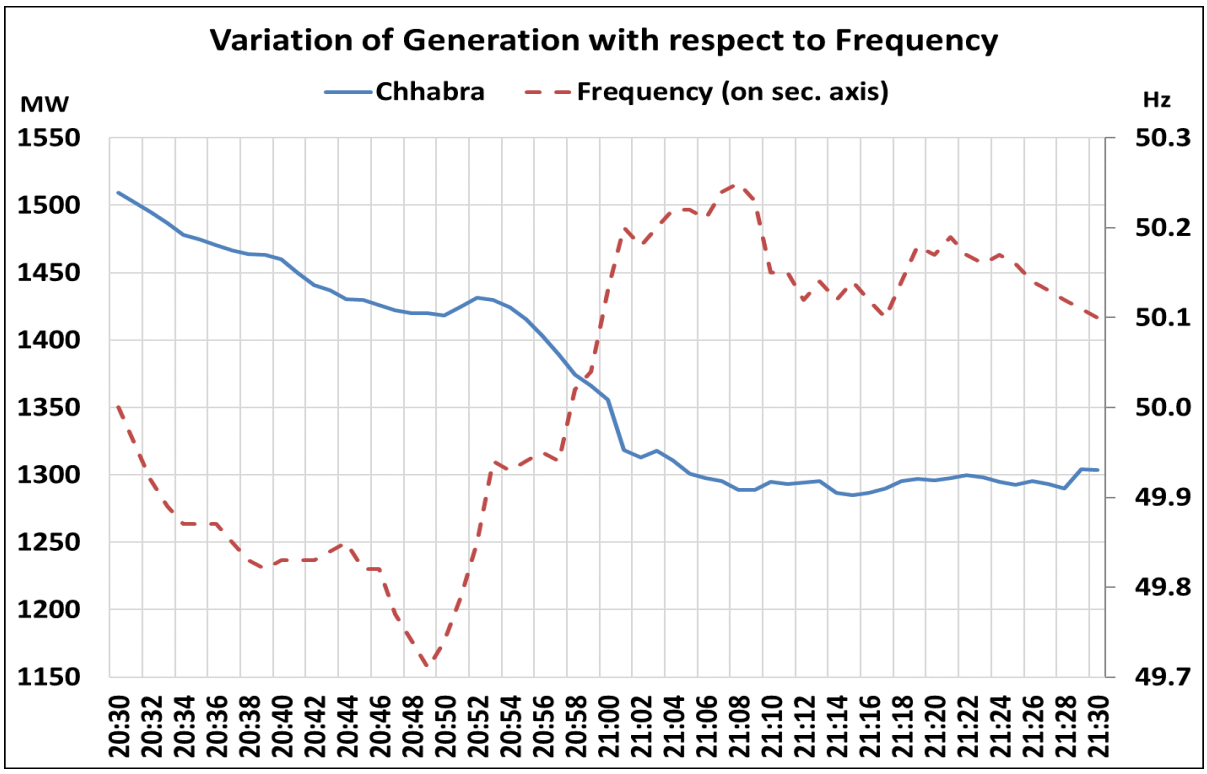


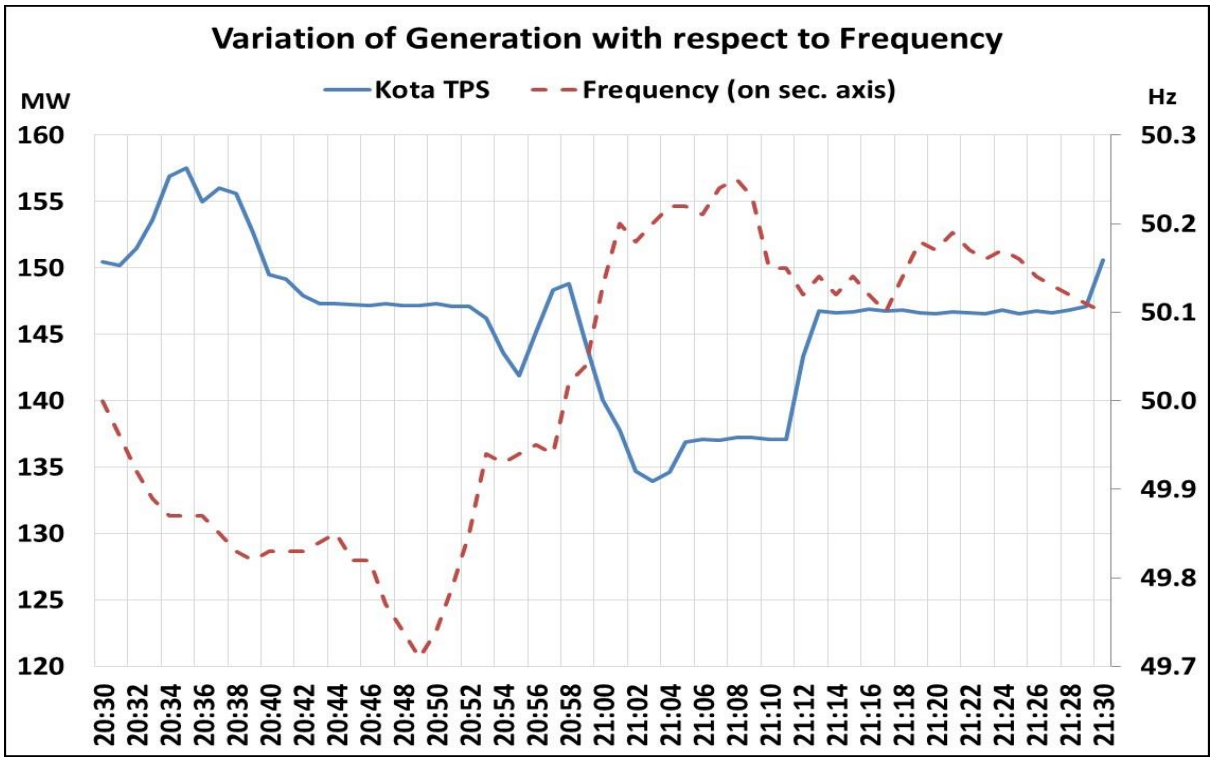

Variation of Generation with respect to Frequency
Rihand-2
Frequency (on sec. axis)
MW
Hz
950
900
850
800
750
700
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

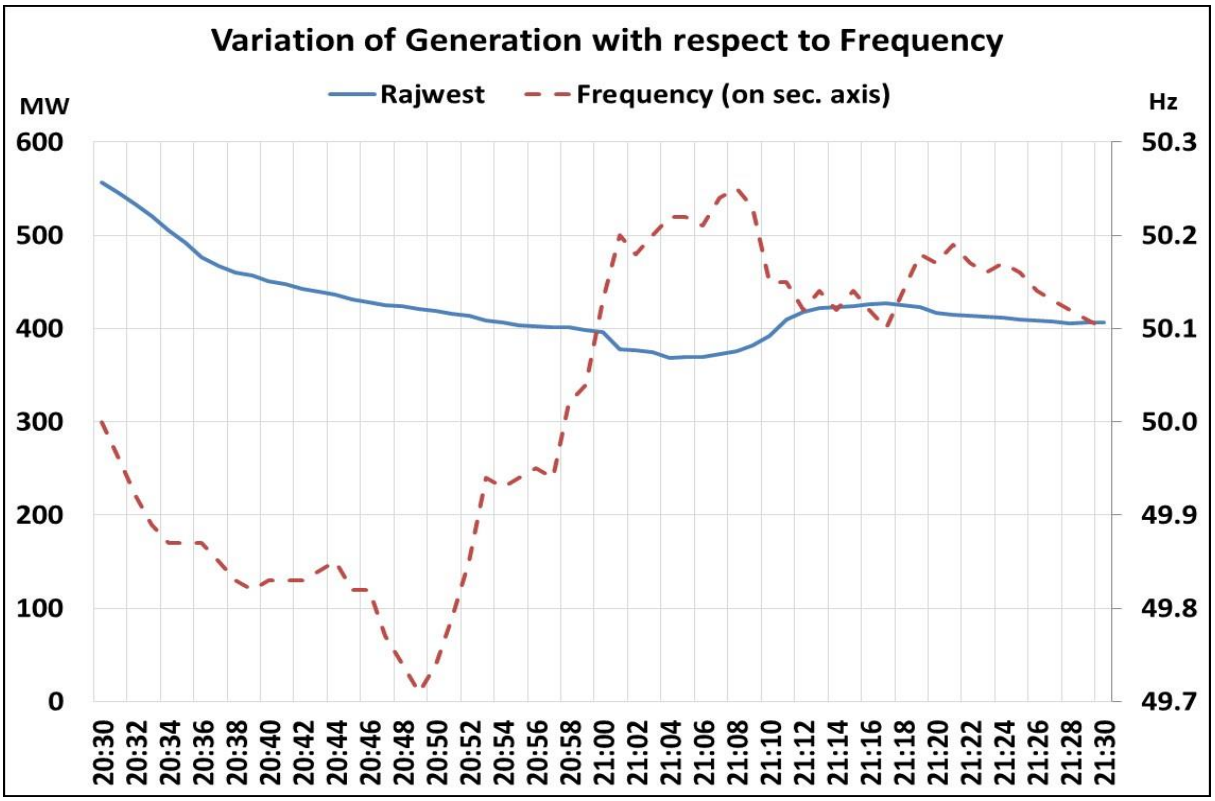

Variation of Generation with respect to Frequency
Rihand-3
Frequency (on sec. axis)
MW
Hz
800
700
600
500
400
300
200
100
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

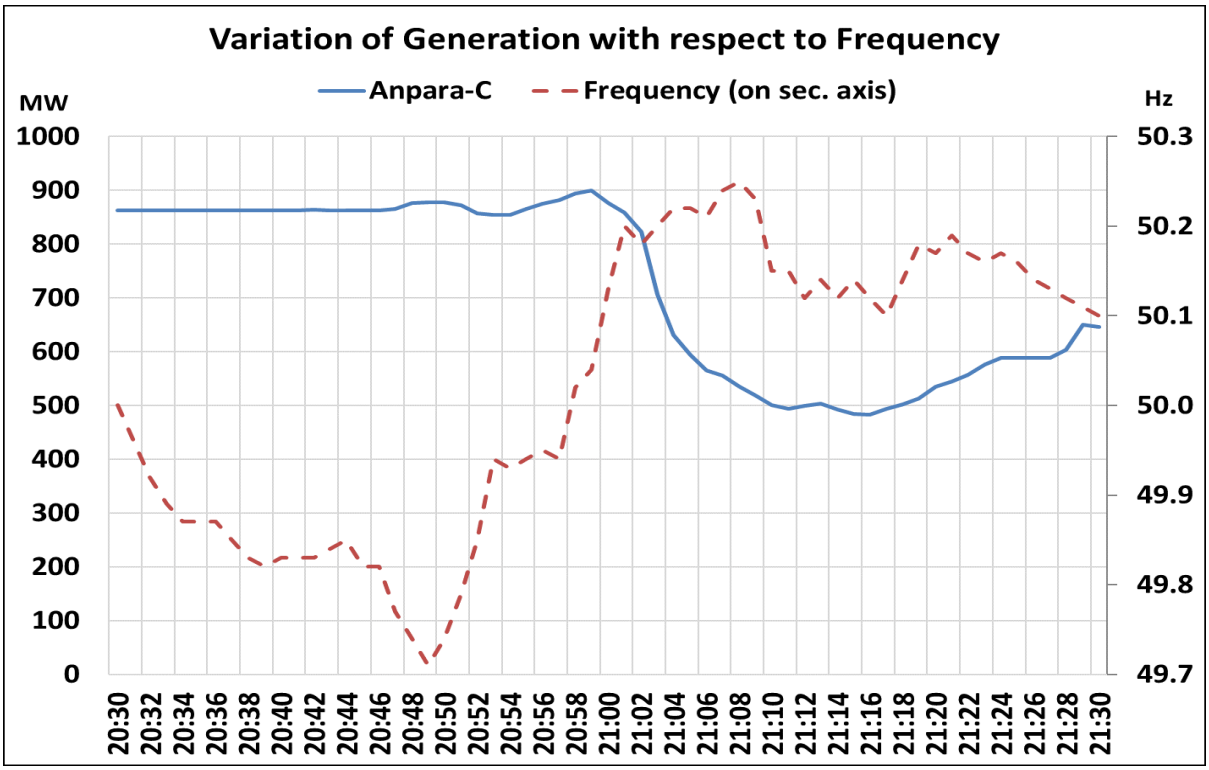

Variation of Generation with respect to Frequency
Singrauli
Frequency (on sec. axis)
MW
Hz
1750
1700
1650
1600
1550
1500
1450
1400
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

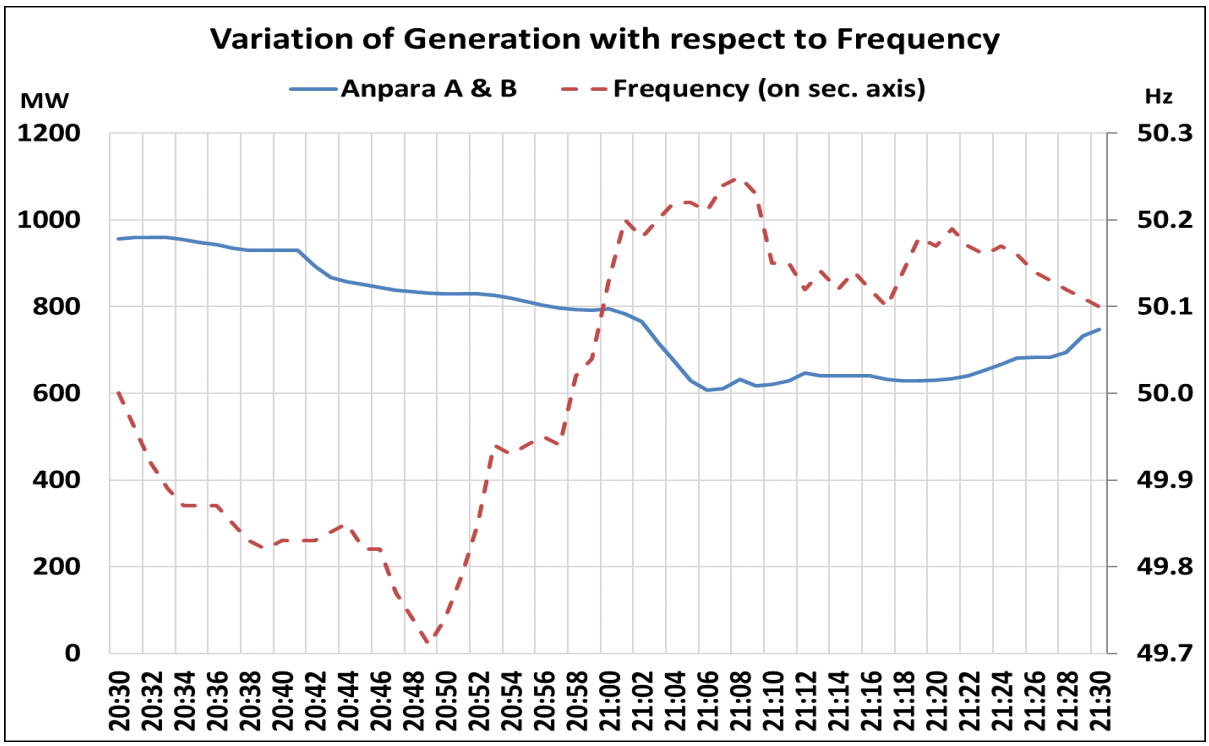

Variation of Generation with respect to Frequency
Barsingsar
Frequency (on sec. axis)
MW
Hz
100
90
80
70
60
50
40
30
20
10
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

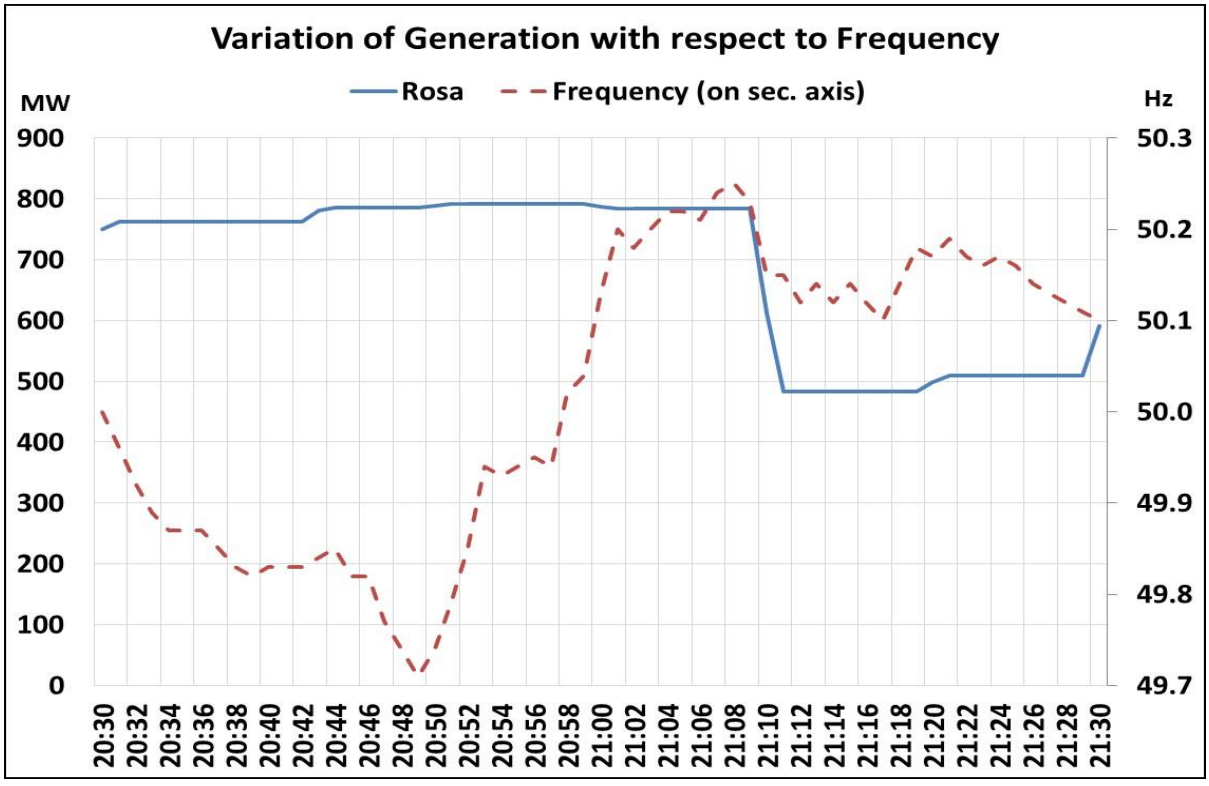

Variation of Generation with respect to Frequency
Chhabra
Frequency (on sec. axis)
MW
Hz
1550
1500
1450
1400
1350
1300
1250
1200
1150
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

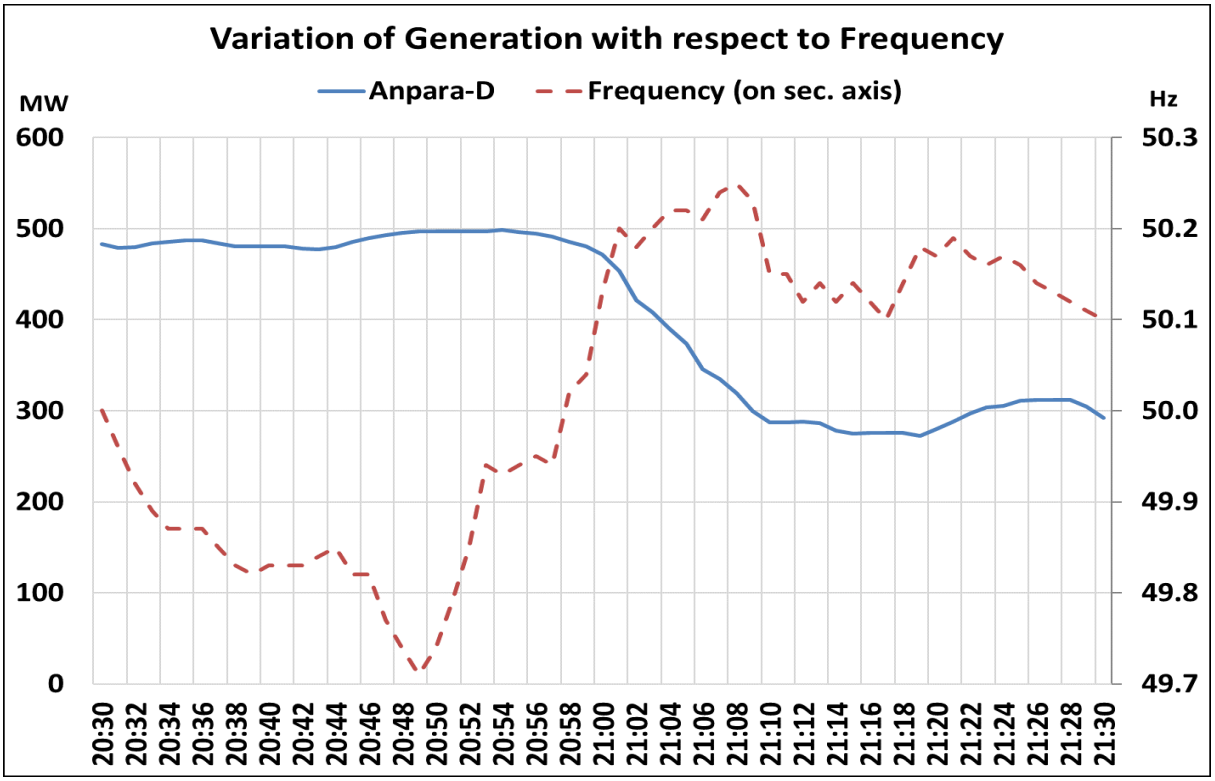

Variation of Generation with respect to Frequency
Kota TPS
Frequency (on sec. axis)
MW
Hz
160
155
150
145
140
135
130
125
120
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Rajwest
Frequency (on sec. axis)
MW
Hz
600
500
400
300
200
100
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Anpara-C
Frequency (on sec. axis)
MW
Hz
1000
900
800
700
600
500
400
300
200
100
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Anpara A & B
Frequency (on sec. axis)
MW
Hz
1200
1000
800
600
400
200
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Rosa
Frequency (on sec. axis)
MW
Hz
900
800
700
600
500
400
300
200
100
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Anpara-D
Frequency (on sec. axis)
MW
Hz
600
500
400
300
200
100
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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21:14
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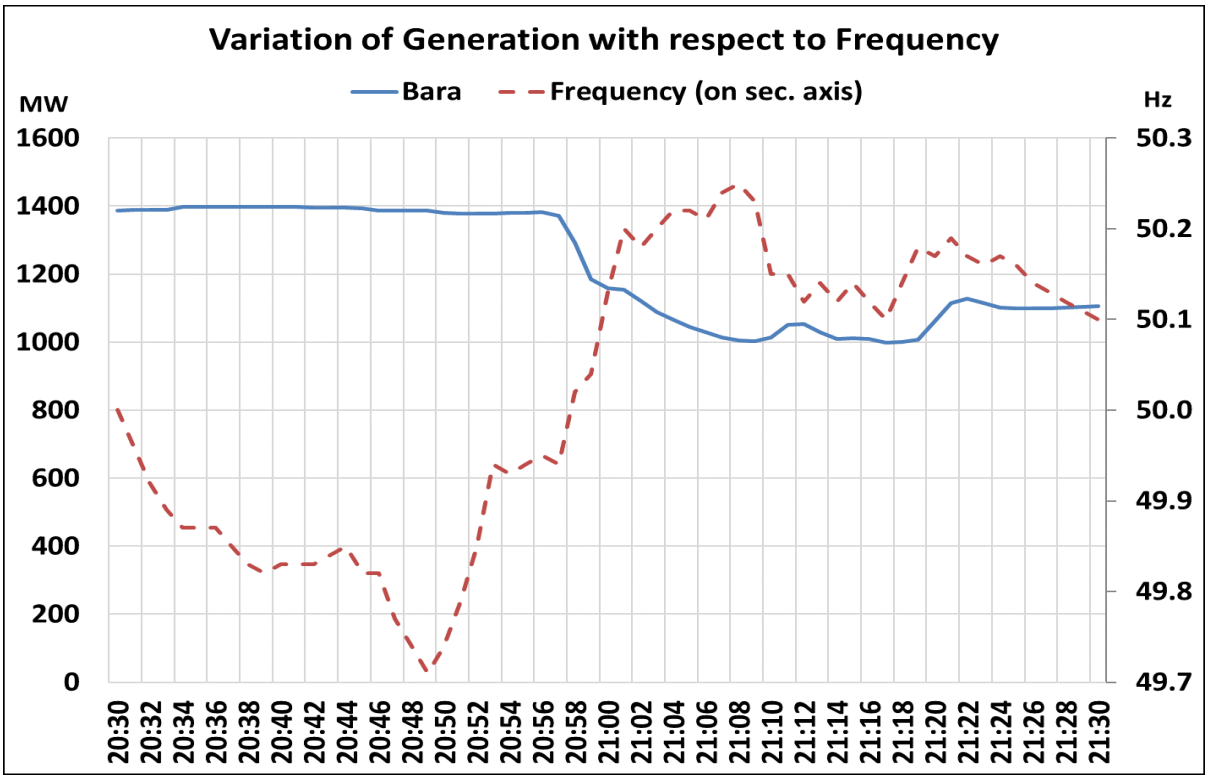
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Bara
Frequency (on sec. axis)
MW
Hz
1600
1400
1200
1000
800
600
400
200
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
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21:08
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21:22
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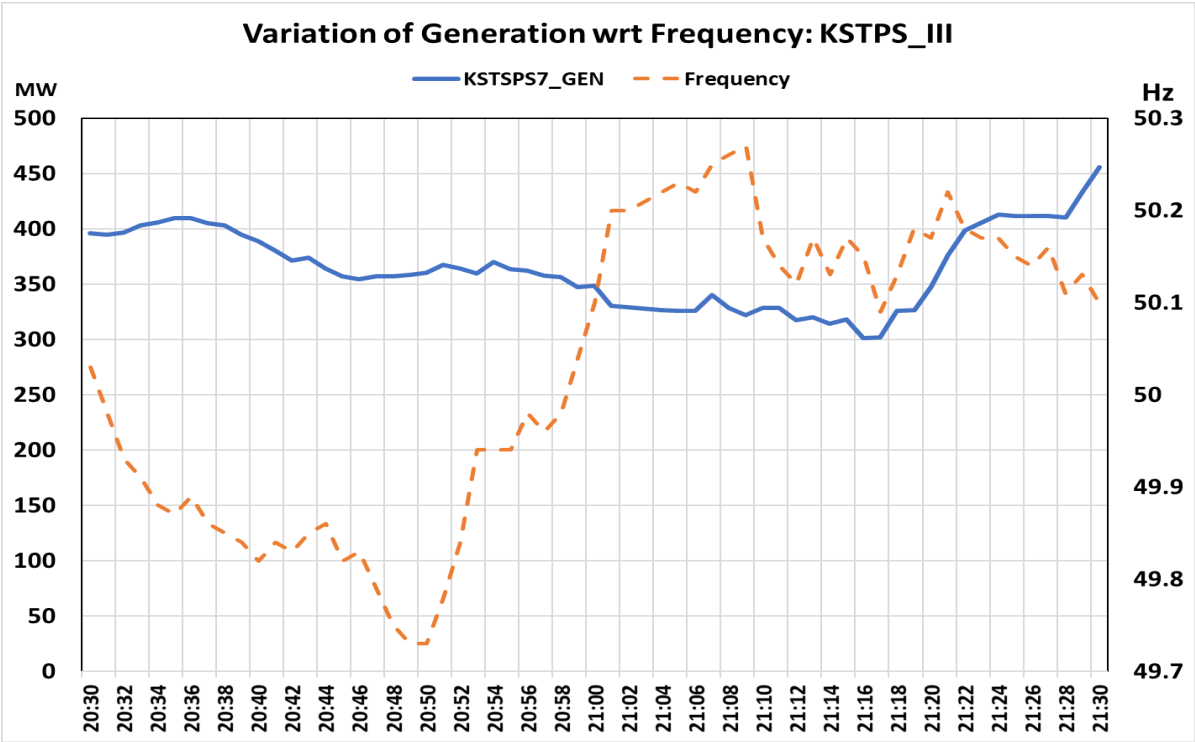
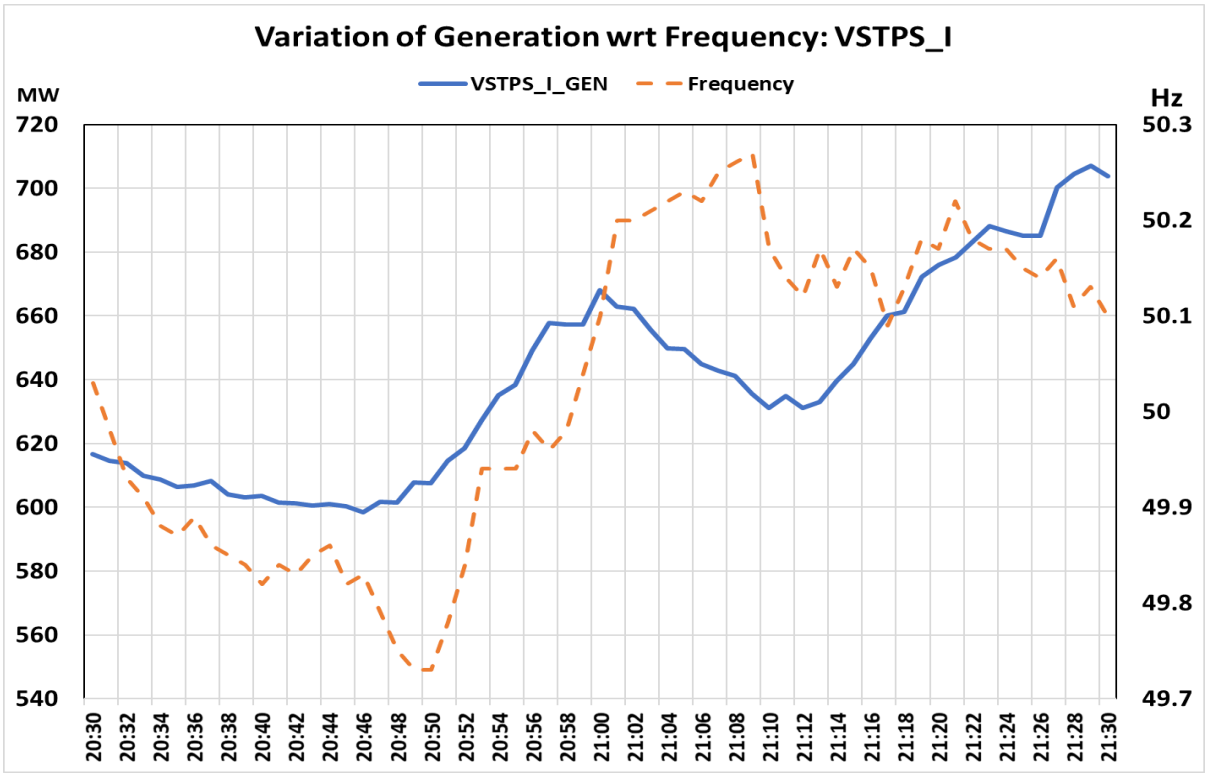
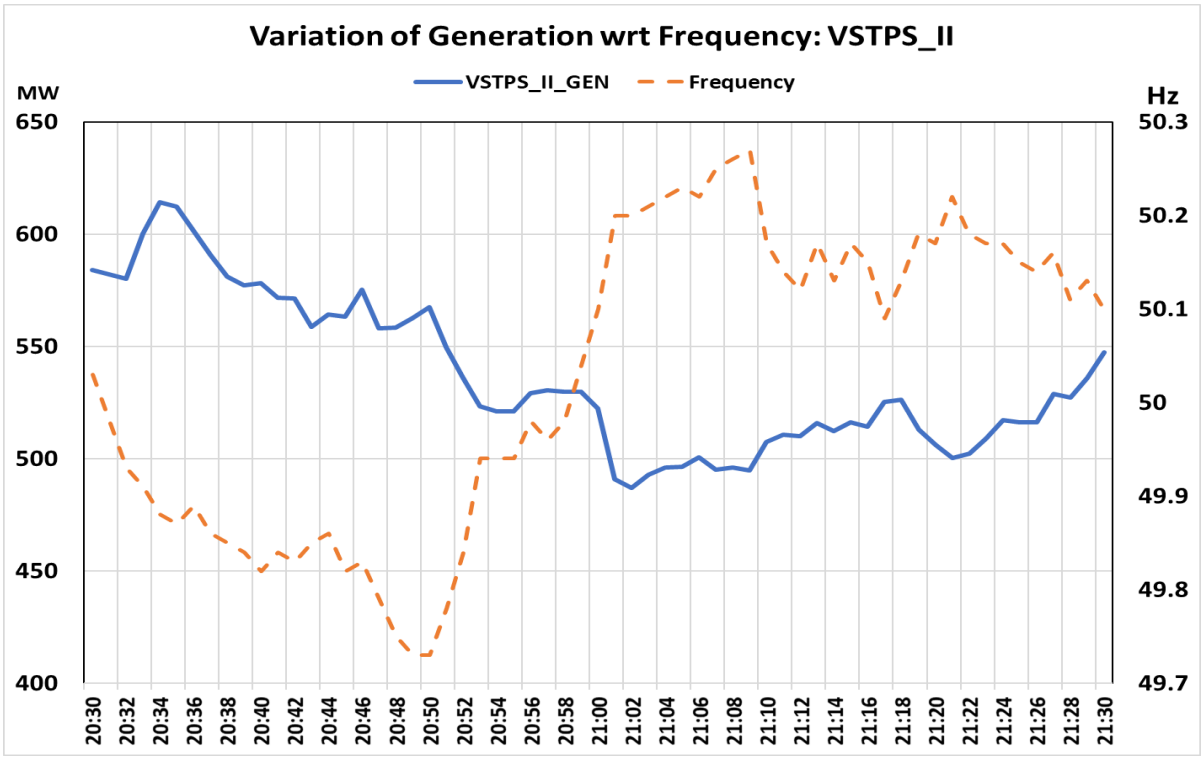
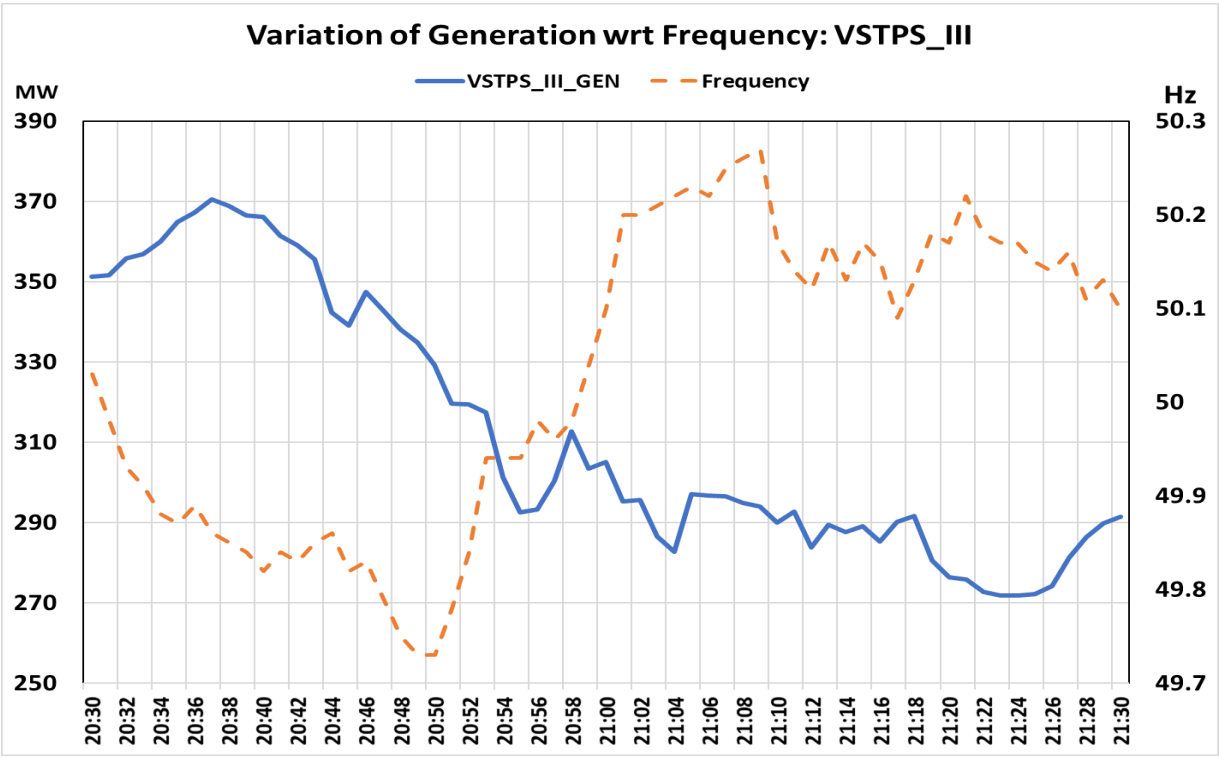
21:30

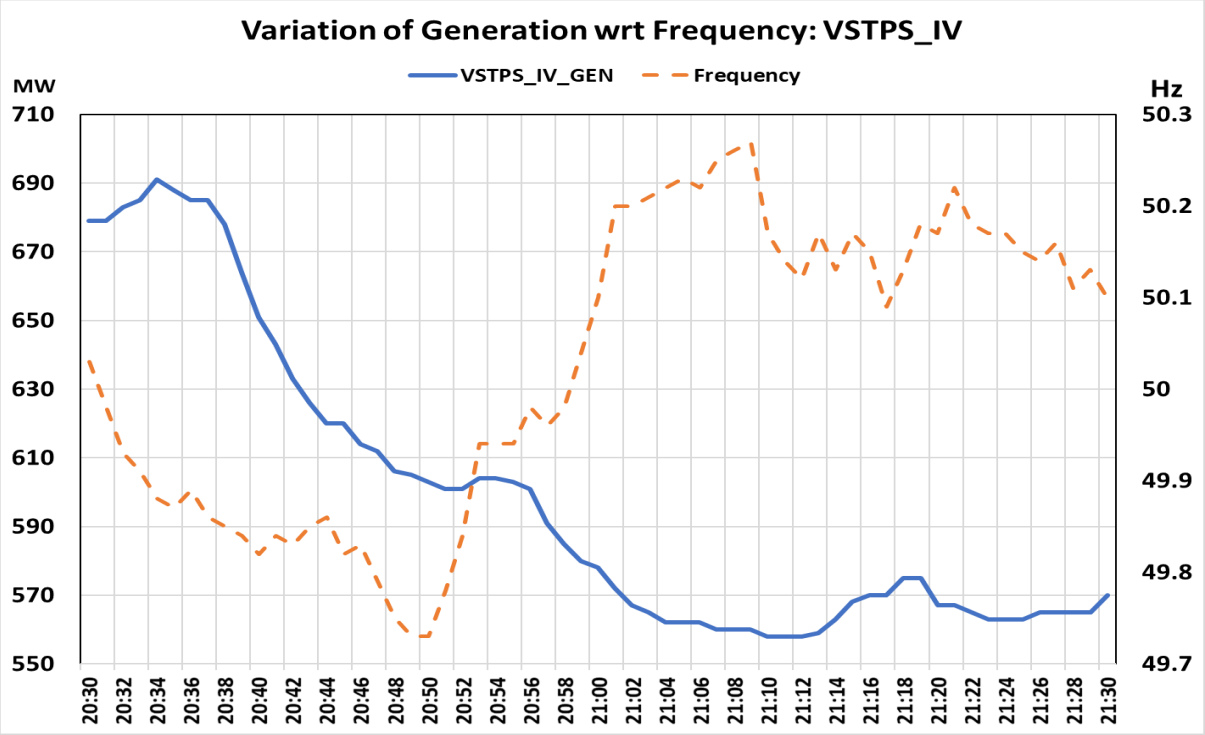
Western Region

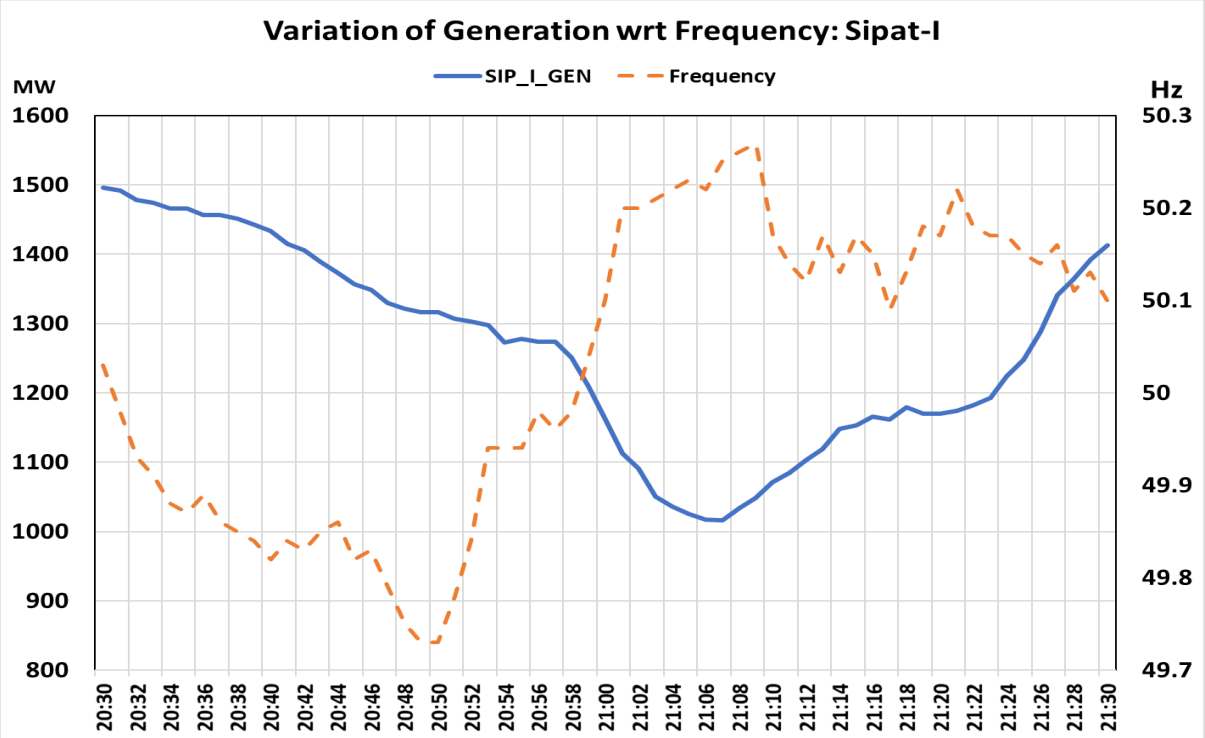


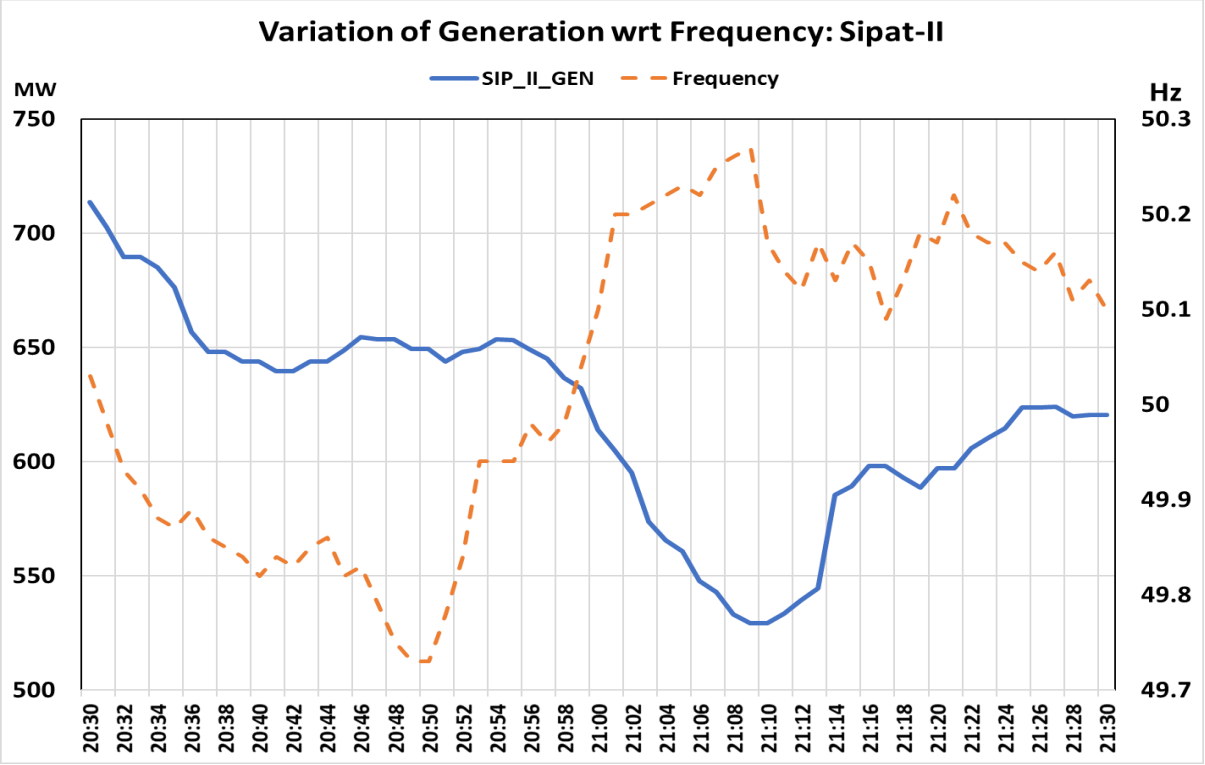



Variation of Generation wrt Frequency: VSTPS_II
VSTPS_II_GEN
Frequency
MW
Hz
650
600
550
500
450
400
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation wrt Frequency: VSTPS_III
VSTPS_III_GEN
Frequency
MW
Hz
390
370
350
330
310
290
270
250
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation wrt Frequency: VSTPS_IV
VSTPS_IV_GEN
Frequency
MW
Hz
710
690
670
650
630
610
590
570
550
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation wrt Frequency: Sipat-I
SIP_I_GEN
Frequency
MW
Hz
1600
1500
1400
1300
1200
1100
1000
900
800
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation wrt Frequency: Sipat-II
SIP_II_GEN
Frequency
MW
Hz
750
700
650
600
550
500
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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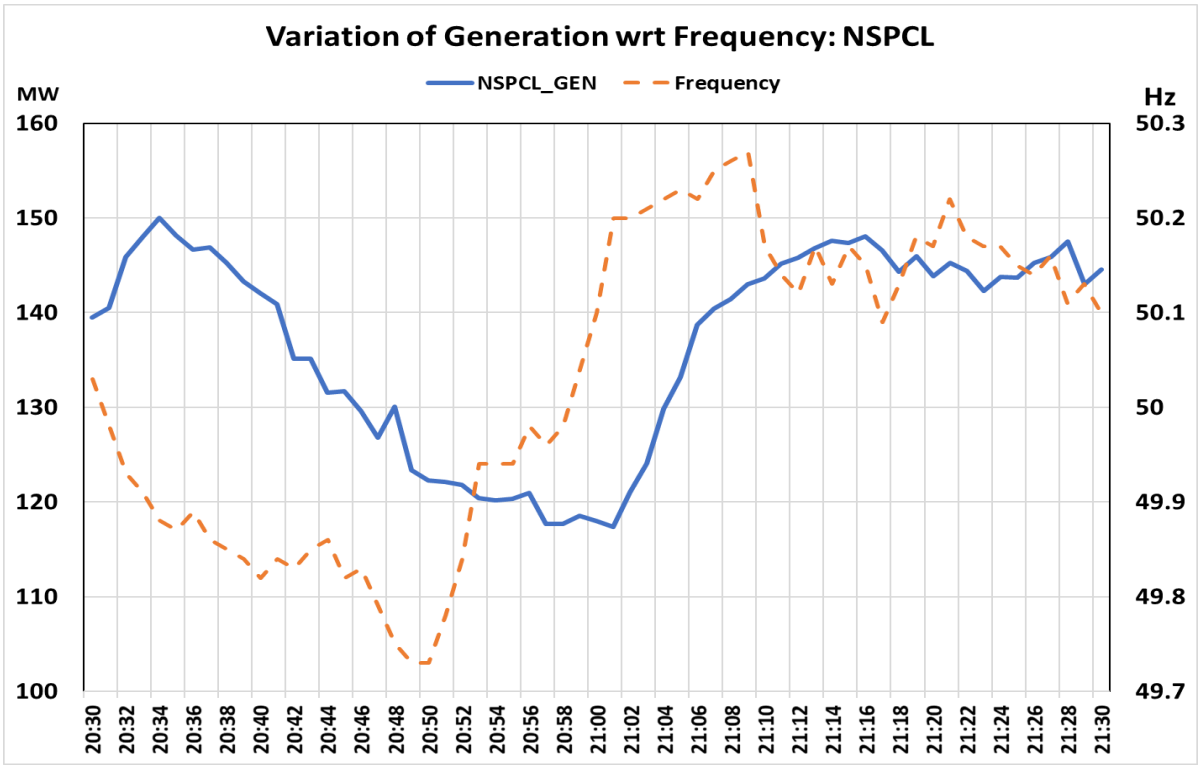
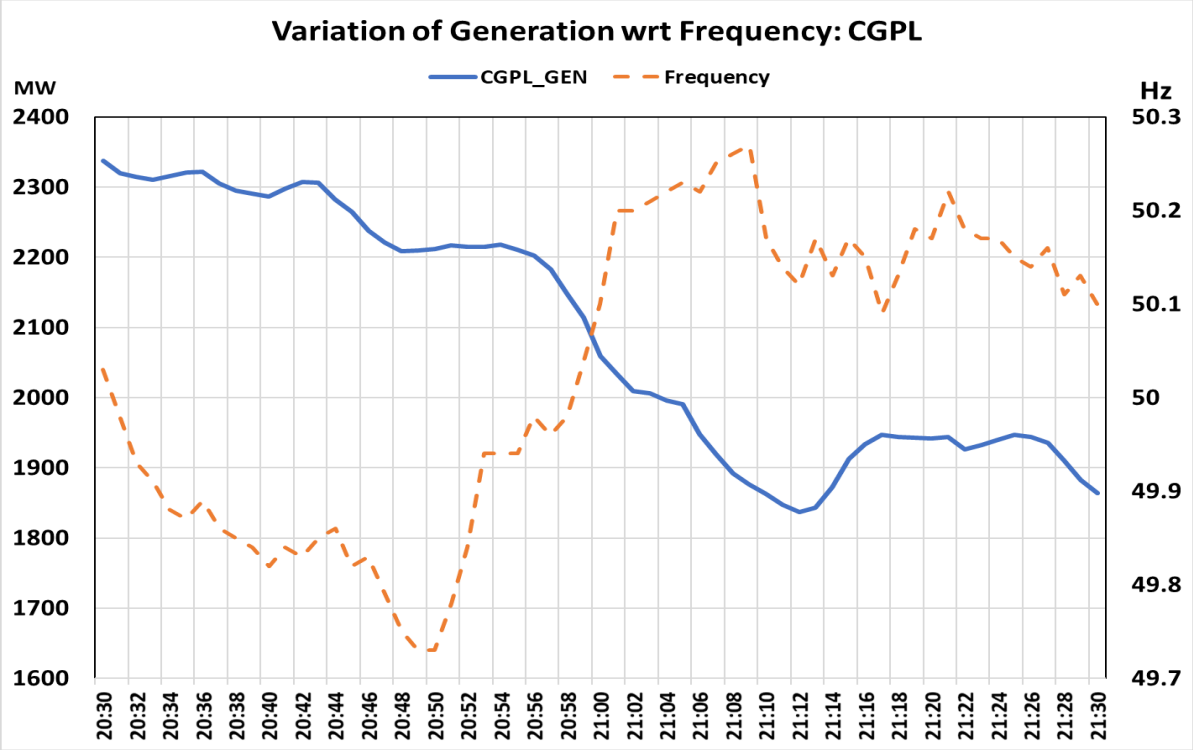
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation wrt Frequency: NSPCL
NSPCL_GEN
Frequency
MW
Hz
160
150
140
130
120
110
100
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation wrt Frequency: CGPL
CGPL_GEN
Frequency
MW
Hz
2400
2300
2200
2100
2000
1900
1800
1700
1600
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
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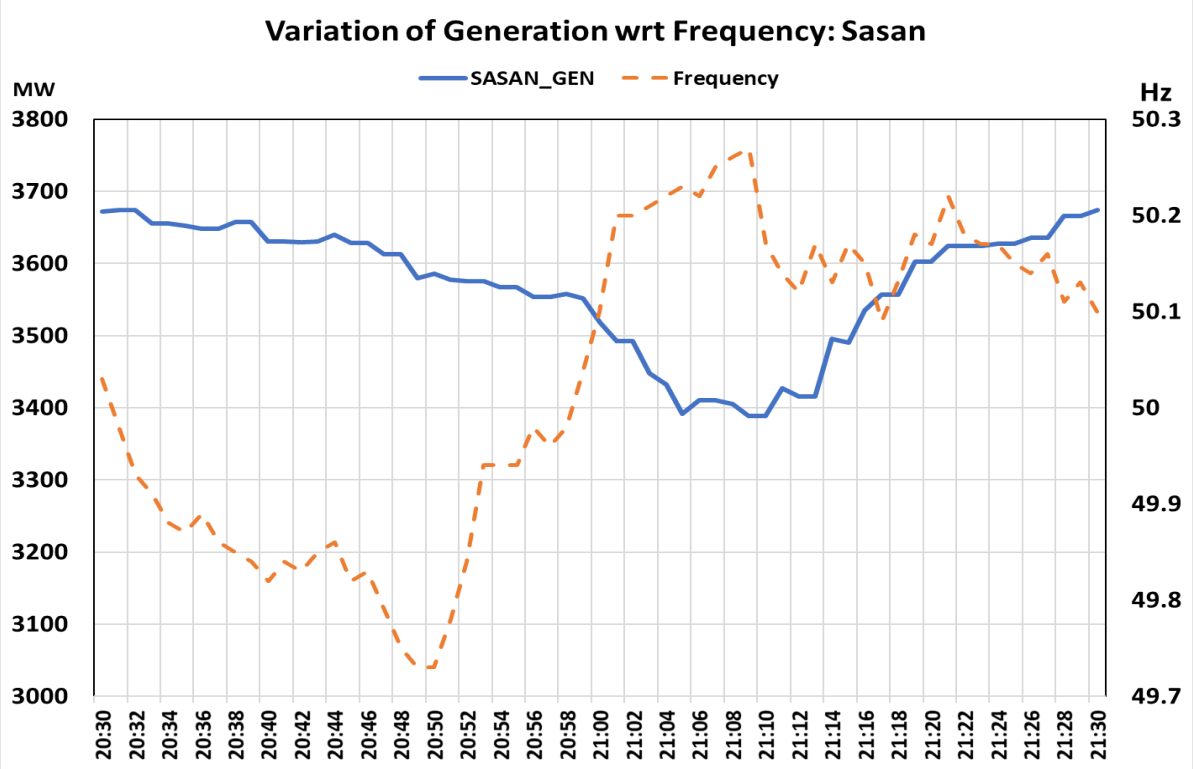
Variation of Generation wrt Frequency: Sasan
SASAN_GEN
Frequency
MW
Hz
3800
3700
3600
3500
3400
3300
3200
3100
3000
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
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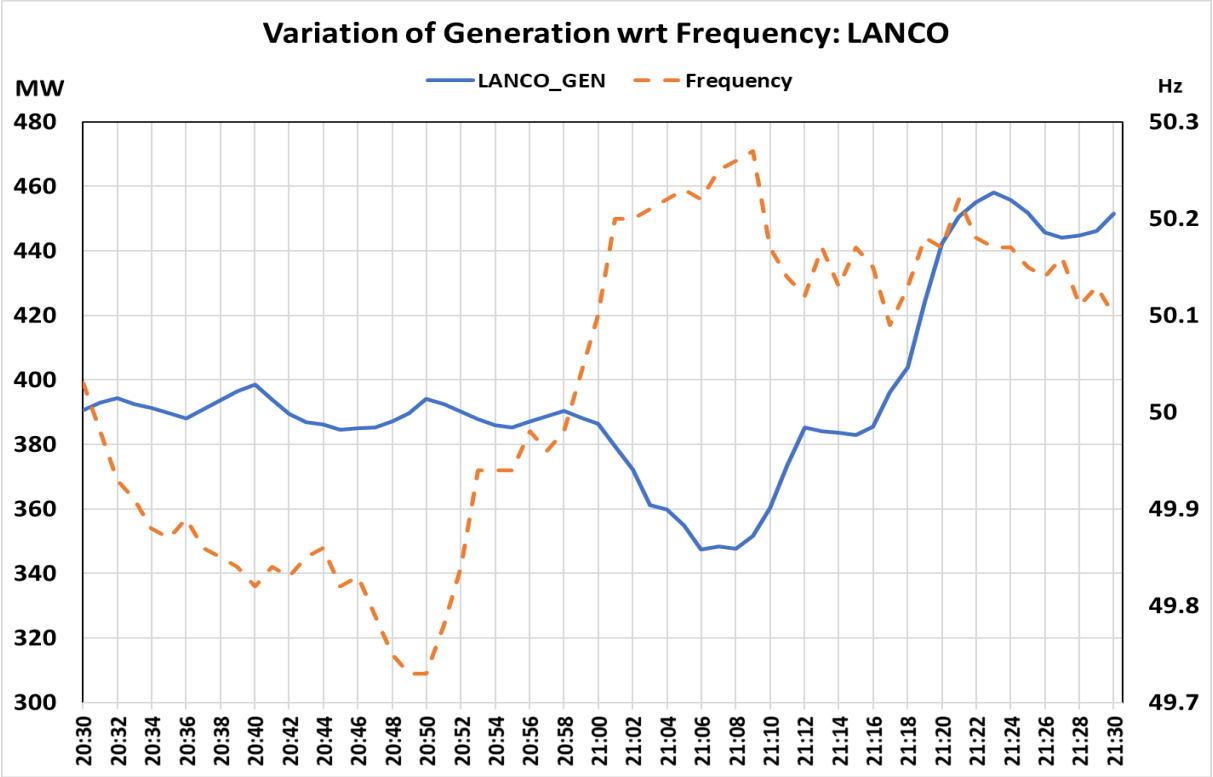
Variation of Generation wrt Frequency: LANCO
LANCO_GEN
Frequency
MW
Hz
480
460
440
420
400
380
360
340
320
300
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
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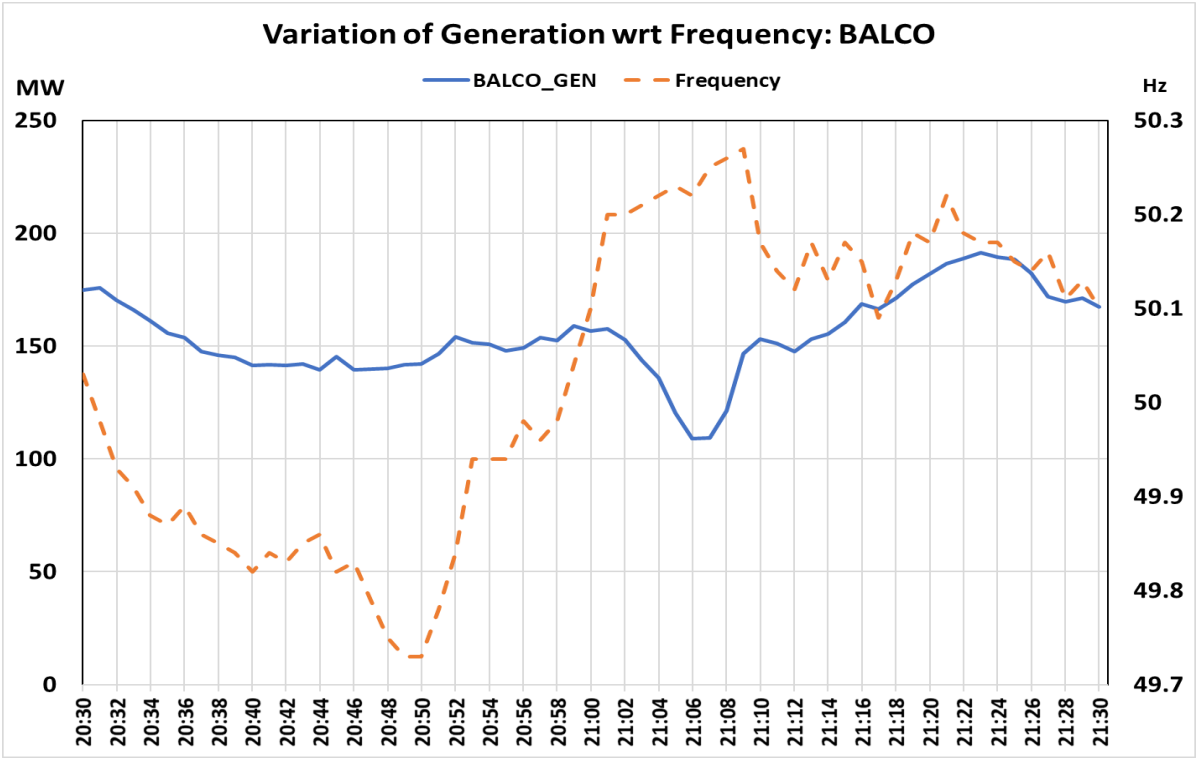
Variation of Generation wrt Frequency: BALCO
BALCO_GEN
Frequency
MW
Hz
250
200
150
100
50
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
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21:00
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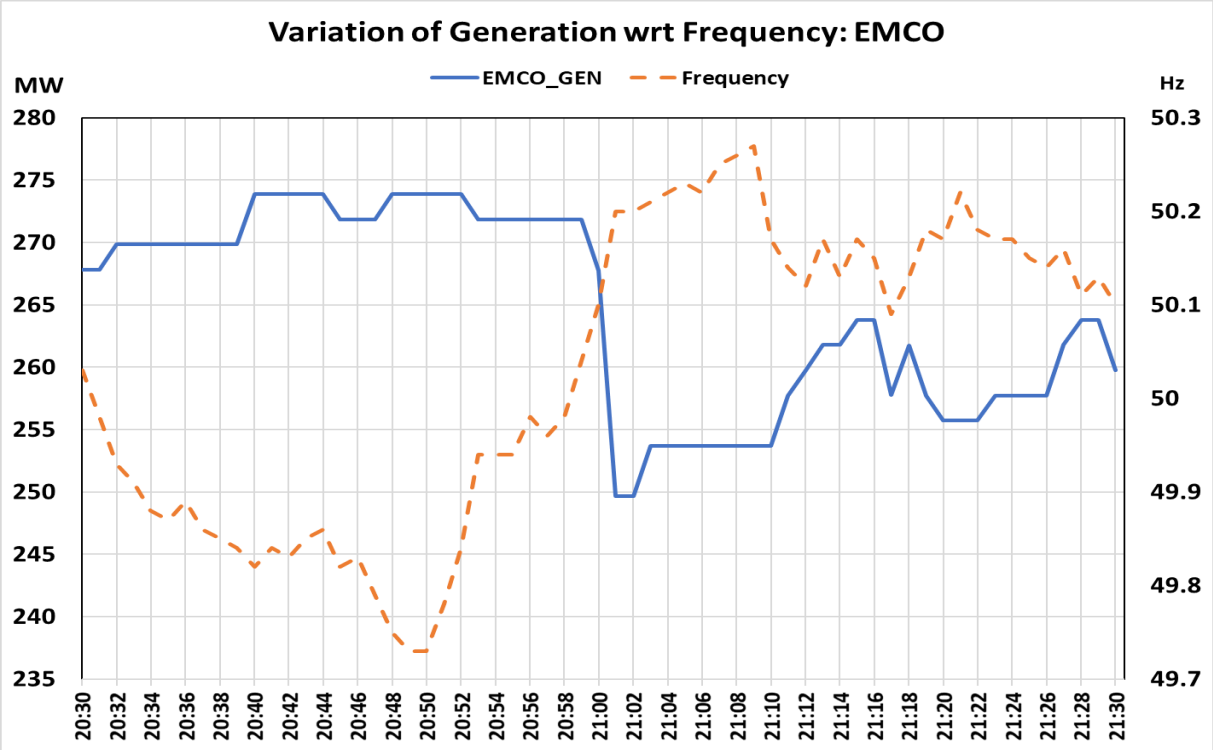
Variation of Generation wrt Frequency: EMCO
EMCO_GEN
Frequency
MW
Hz
280
275
270
265
260
255
250
245
240
235
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
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21:22
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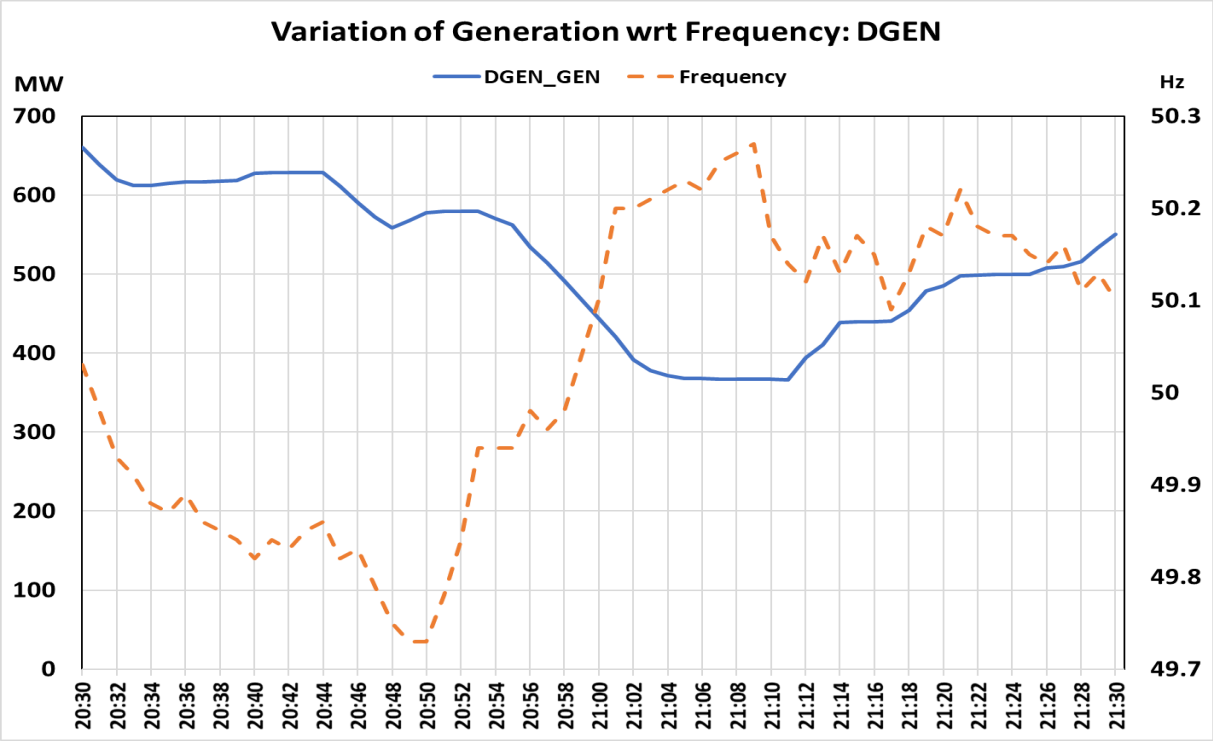
Variation of Generation wrt Frequency: DGEN
DGEN_GEN
Frequency
MW
Hz
700
600
500
400
300
200
100
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
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21:22
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21:28
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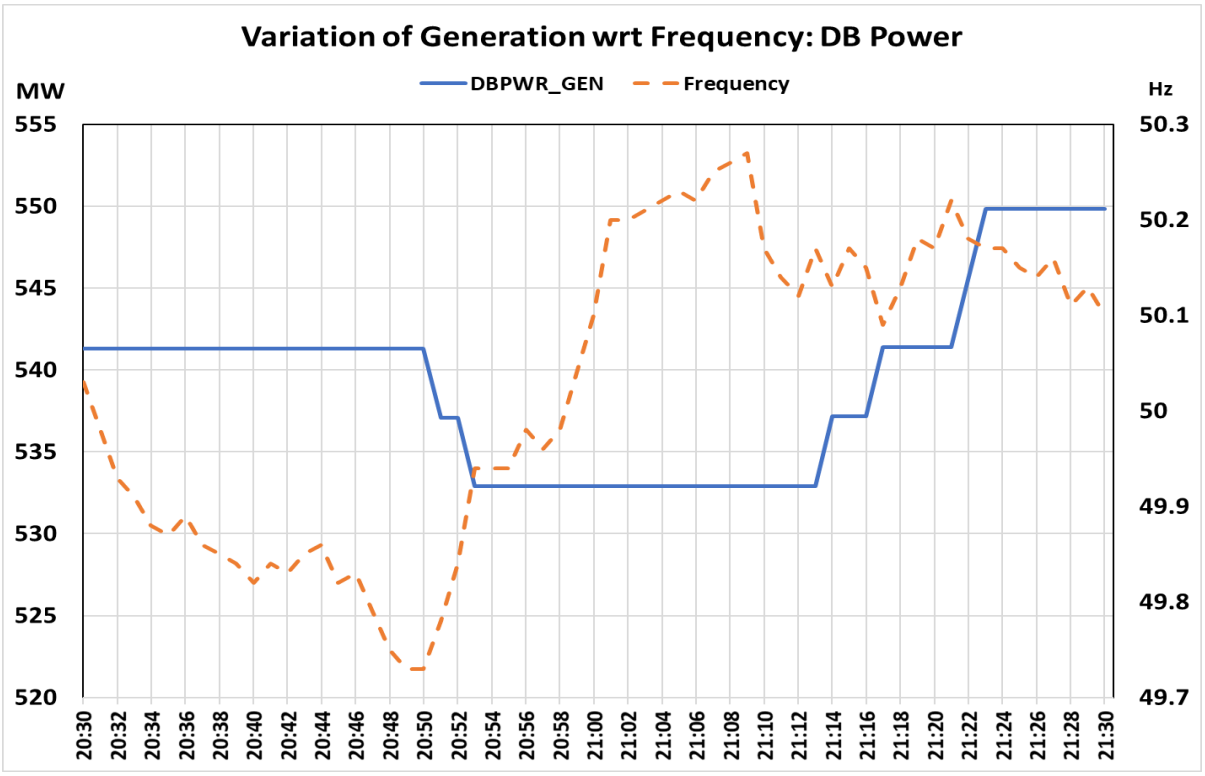
Variation of Generation wrt Frequency: DB Power
DBPWR_GEN
Frequency
MW
Hz
555
550
545
540
535
530
525
520
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
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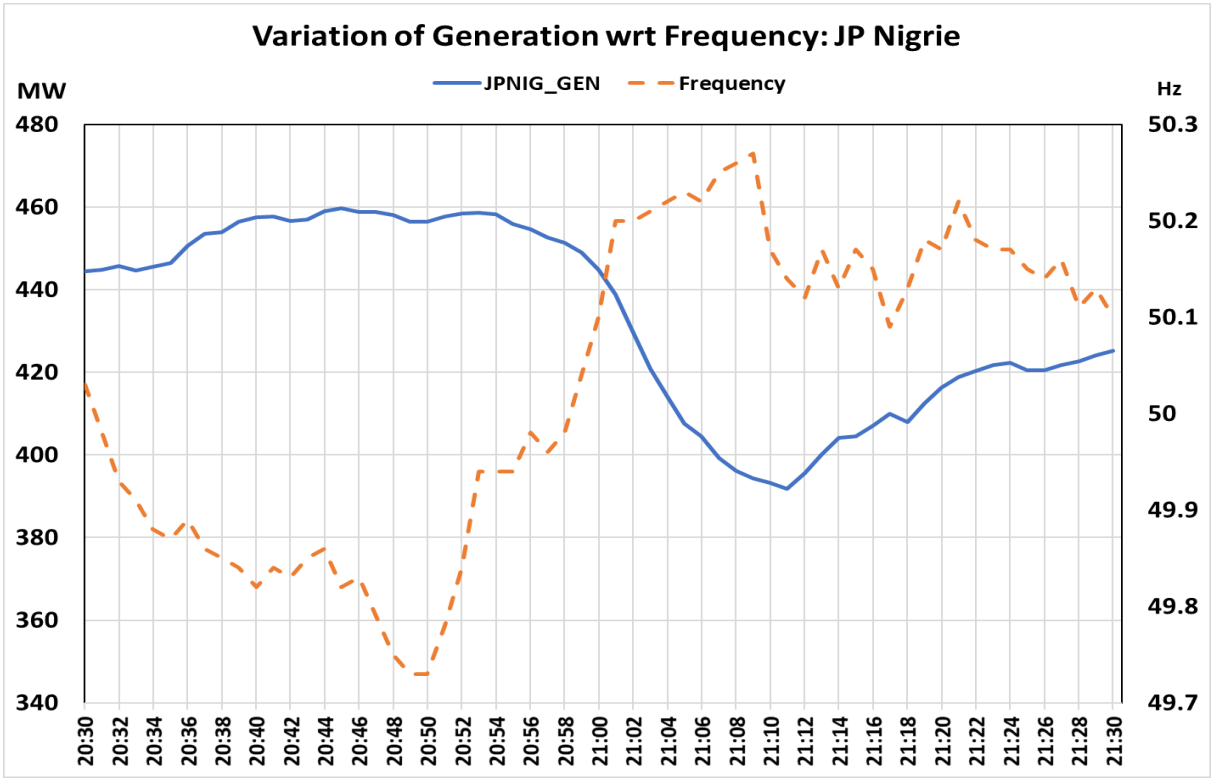
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation wrt Frequency: JP Nigrie
JPNIG_GEN
Frequency
MW
Hz
480
460
440
420
400
380
360
340
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
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20:50
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21:12
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21:22
21:24
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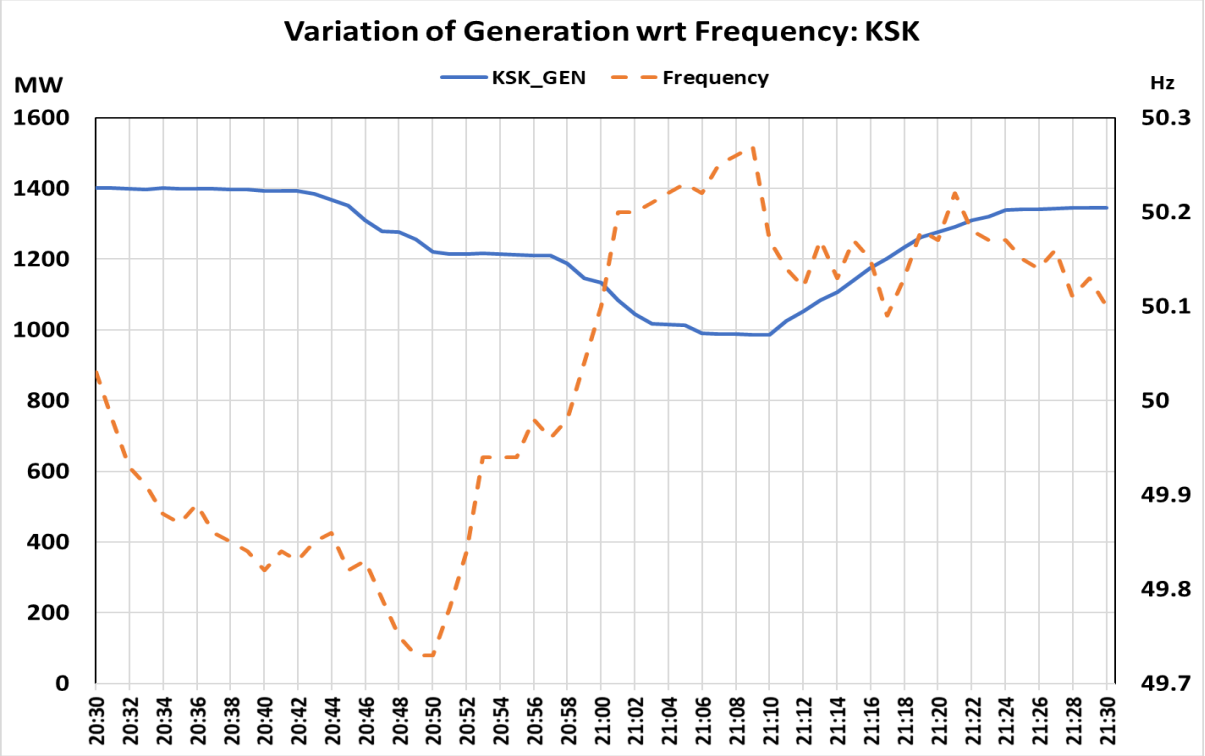
21:28
21:30


Variation of Generation wrt Frequency: KSK
KSK_GEN
Frequency
MW
Hz
1600
1400
1200
1000
800
600
400
200
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
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20:56
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21:22
21:24
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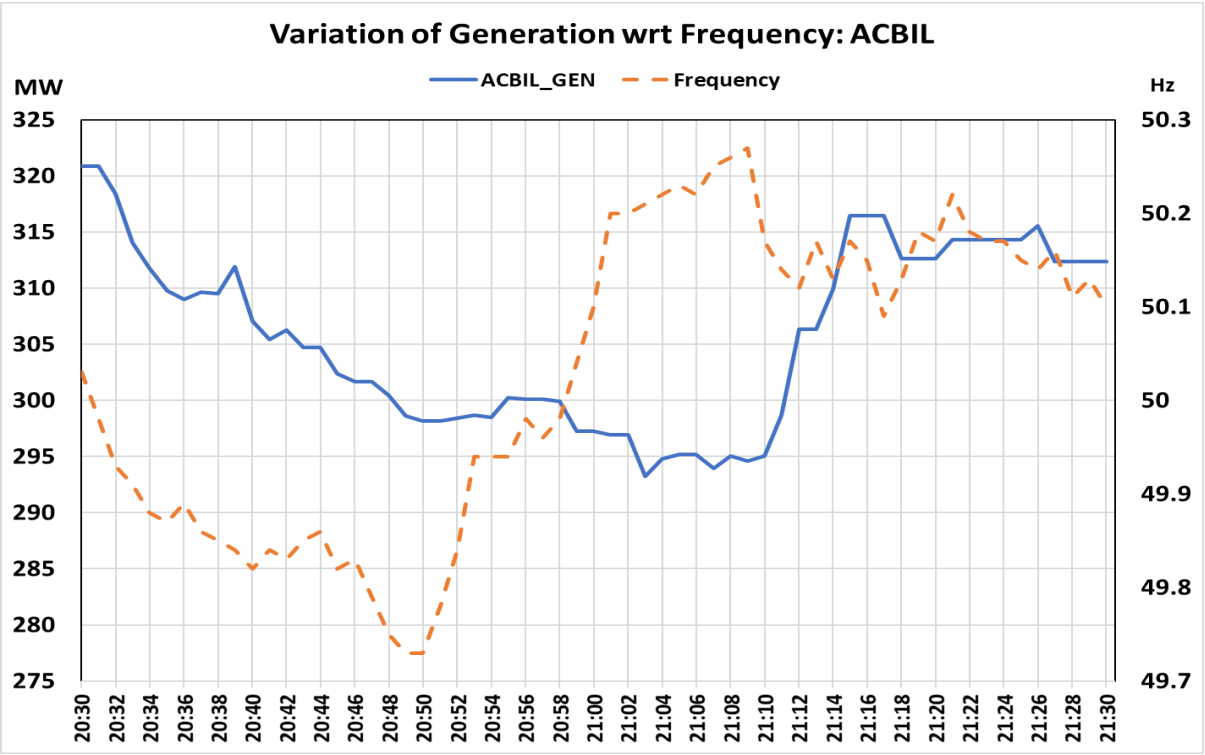
21:28
21:30


Variation of Generation wrt Frequency: ACBIL
ACBIL_GEN
Frequency
MW
Hz
325
320
315
310
305
300
295
290
285
280
275
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
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21:12
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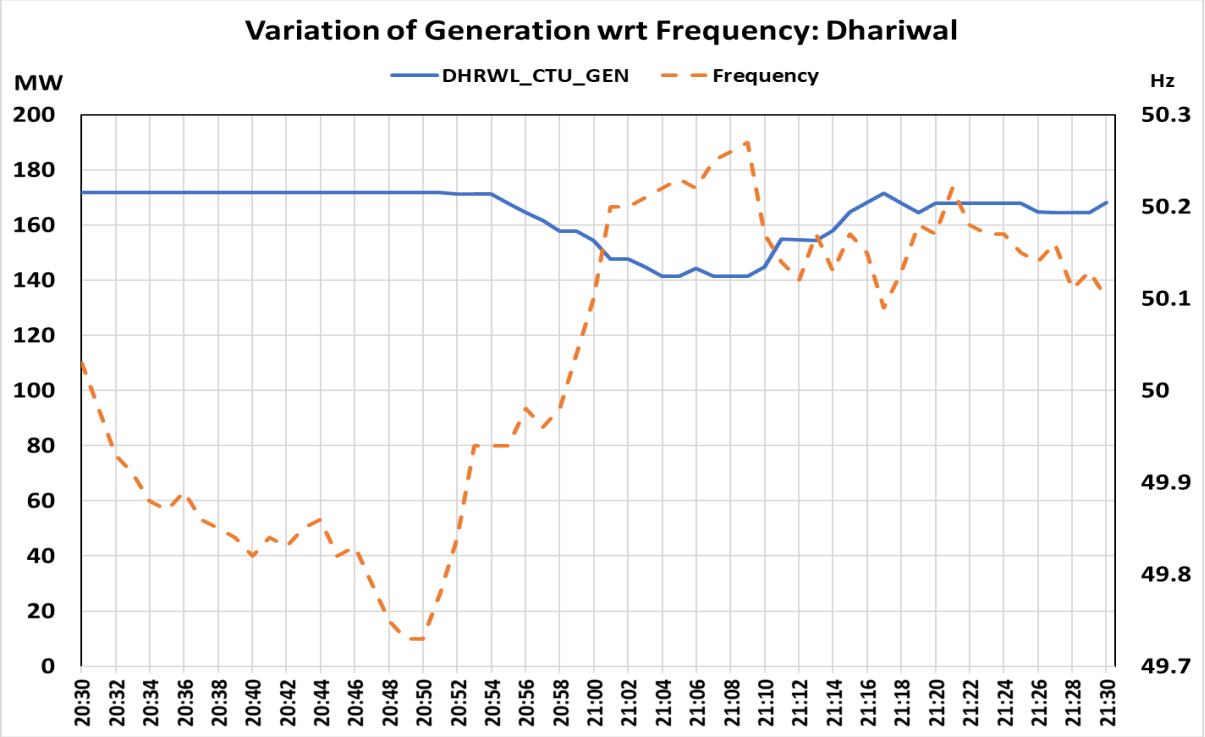
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation wrt Frequency: Dhariwal
DHRWL_CTU_GEN
Frequency
MW
Hz
200
180
160
140
120
100
80
60
40
20
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
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21:14
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21:22
21:24
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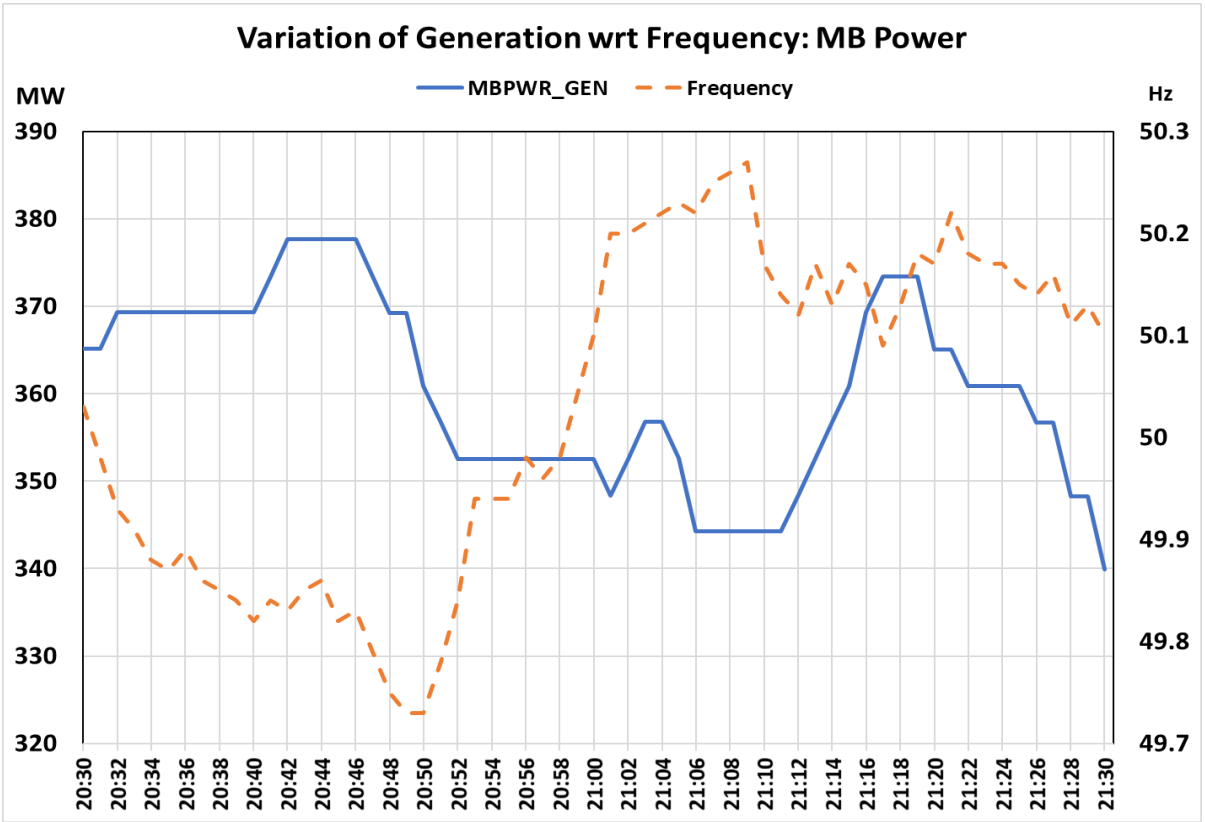
21:28
21:30


Variation of Generation wrt Frequency: MB Power
MBPWR_GEN
Frequency
MW
Hz
390
380
370
360
350
340
330
320
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
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21:24
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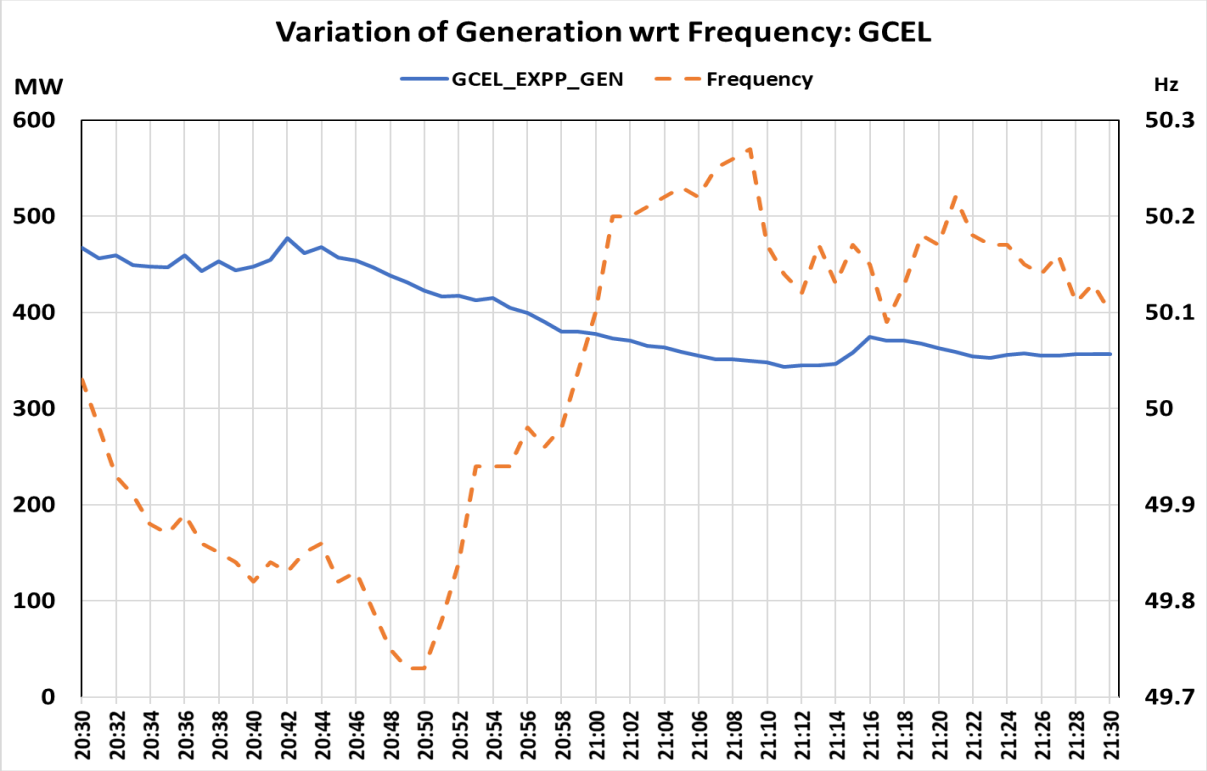
21:30


Variation of Generation wrt Frequency: GCEL
GCEL_EXPP_GEN
Frequency
MW
Hz
600
500
400
300
200
100
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
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20:50
20:52
20:54
20:56
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21:00
21:02
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21:18
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21:22
21:24
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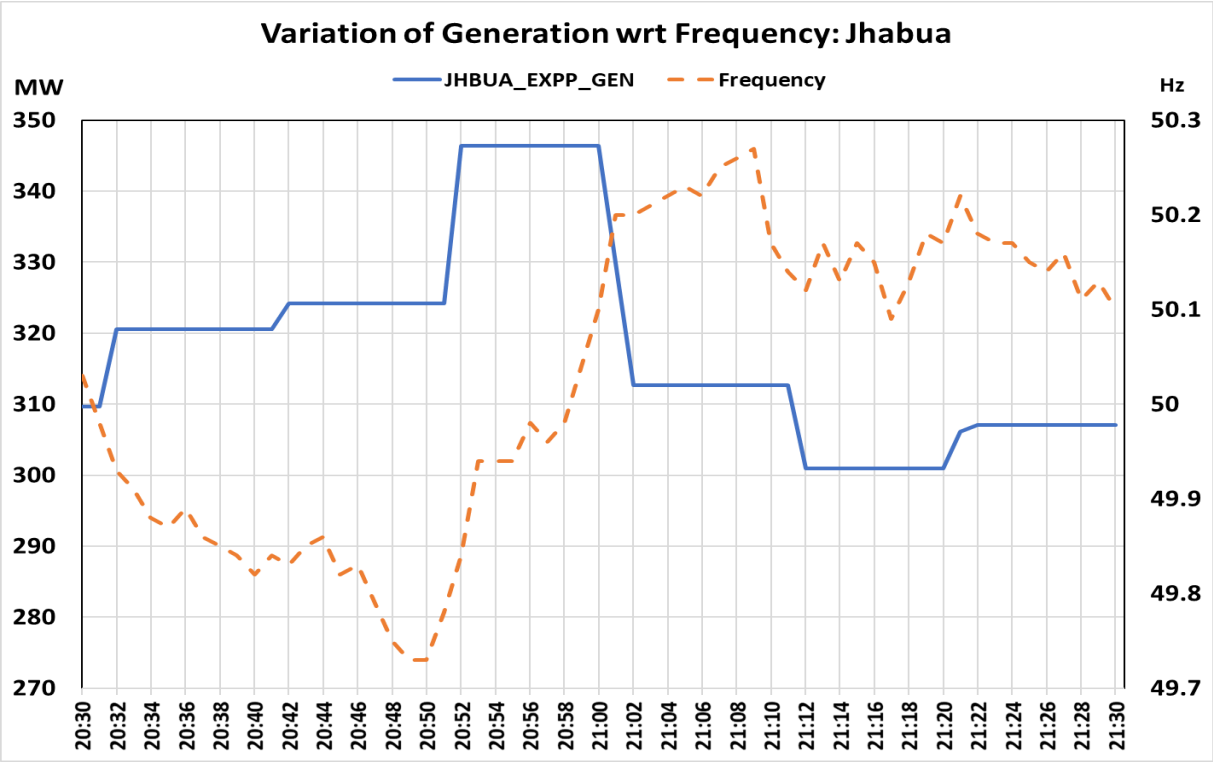
21:28
21:30


Variation of Generation wrt Frequency: Jhabua
JHBUA_EXPP_GEN
Frequency
MW
Hz
350
340
330
320
310
300
290
280
270
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
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21:06
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21:12
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21:16
21:18
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21:28
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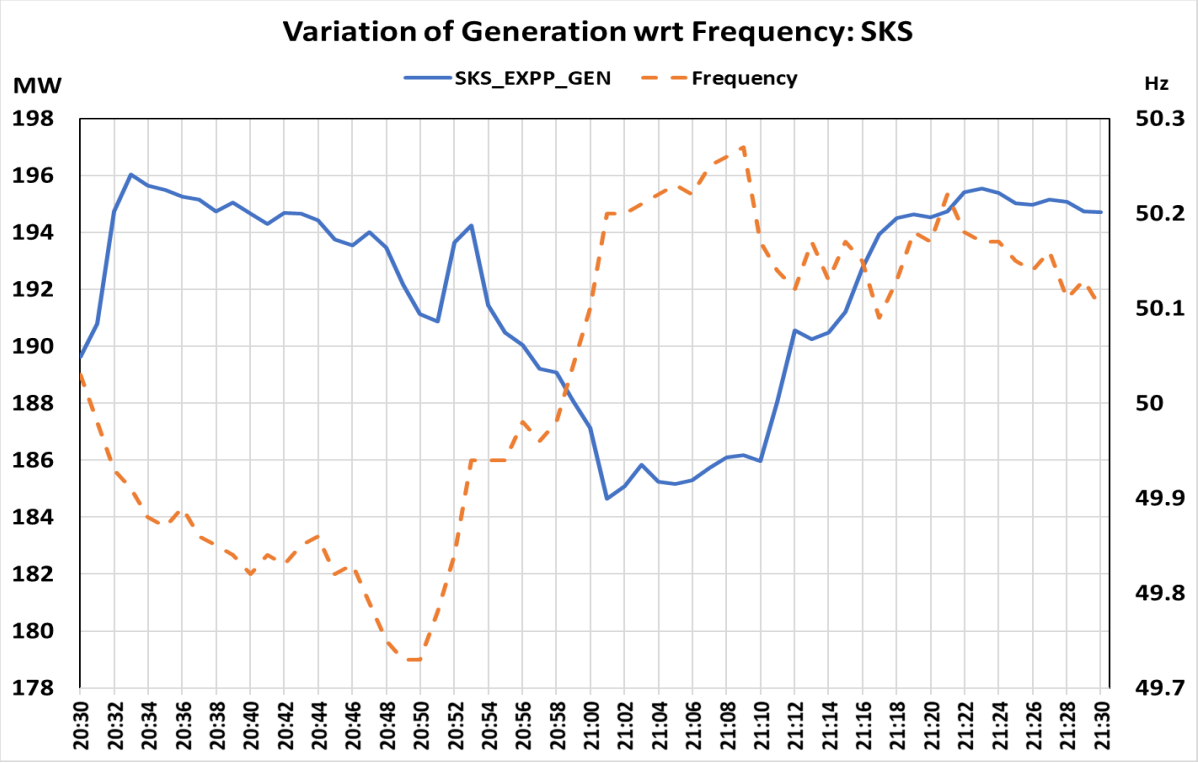
Variation of Generation wrt Frequency: SKS
SKS_EXPP_GEN
Frequency
MW
Hz
198
196
194
192
190
188
186
184
182
180
178
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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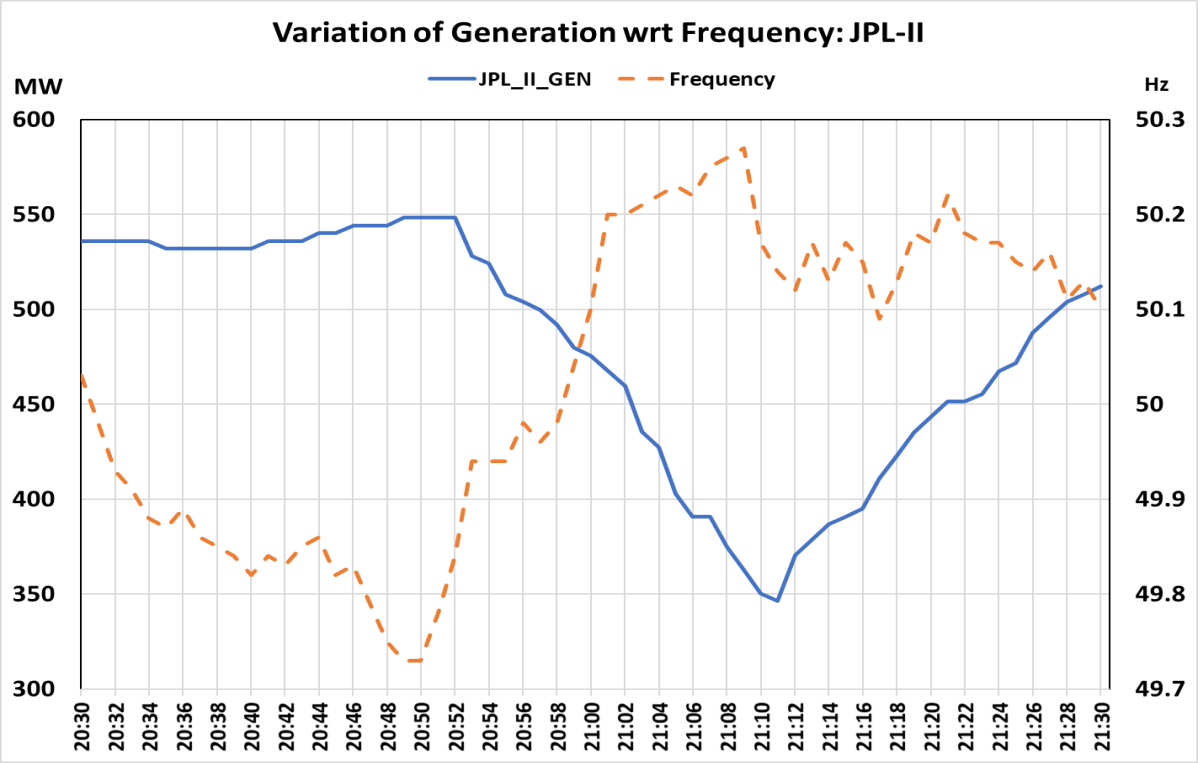
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation wrt Frequency: JPL-II
JPL_II_GEN
Frequency
MW
Hz
600
550
500
450
400
350
300
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
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21:22
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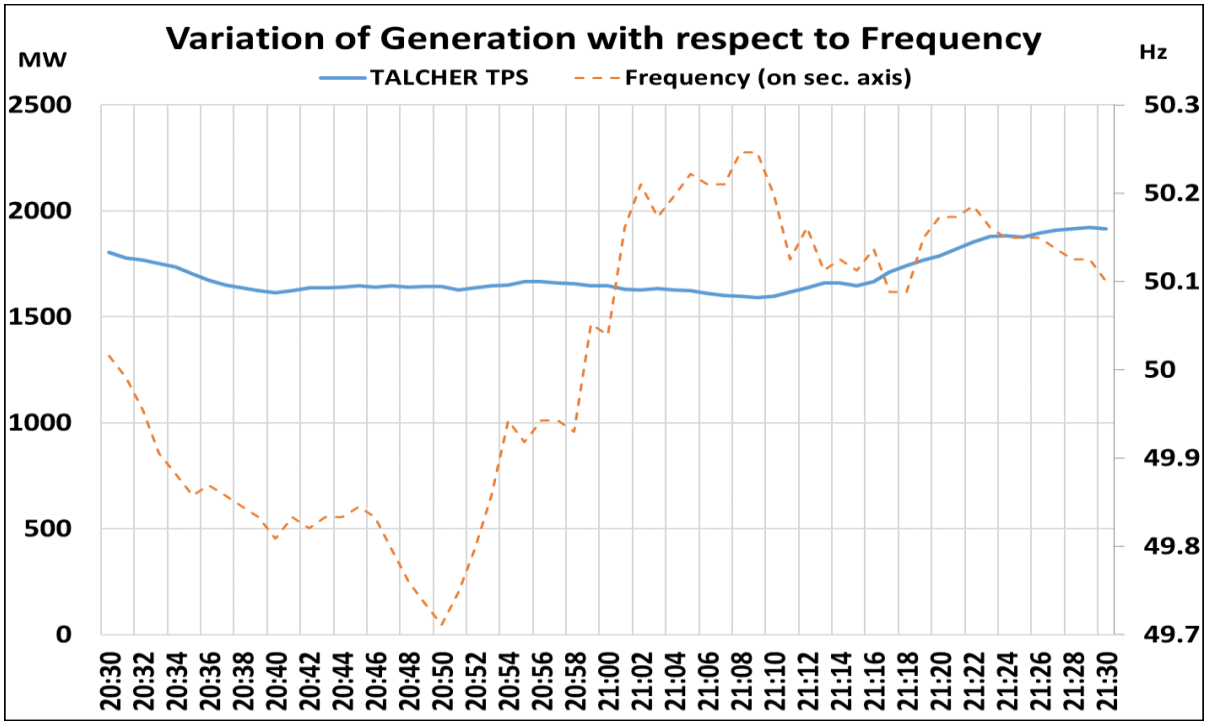
21:30


Variation of Generation with respect to Frequency
MW
Hz
TALCHER TPS
Frequency (on sec. axis)
2500
2000
1500
1000
500
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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21:14
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21:18
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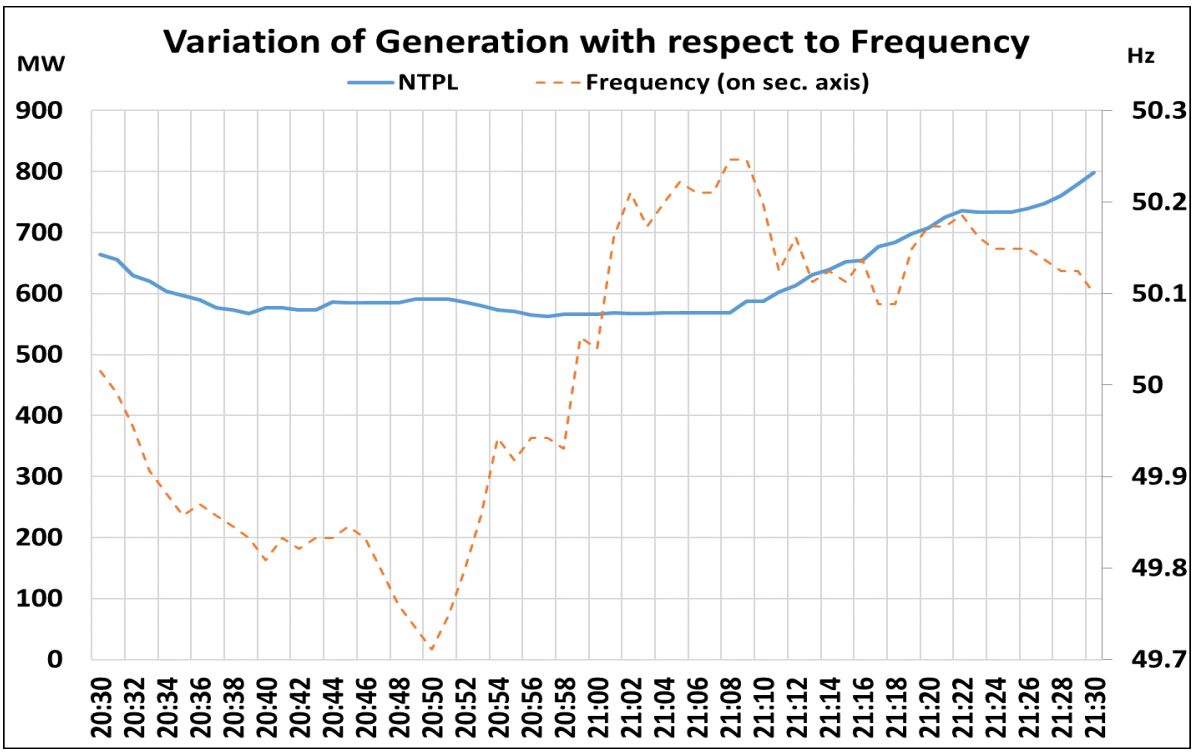
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
MW
Hz
NTPL
Frequency (on sec. axis)
900
800
700
600
500
400
300
200
100
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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21:14
21:16
21:18
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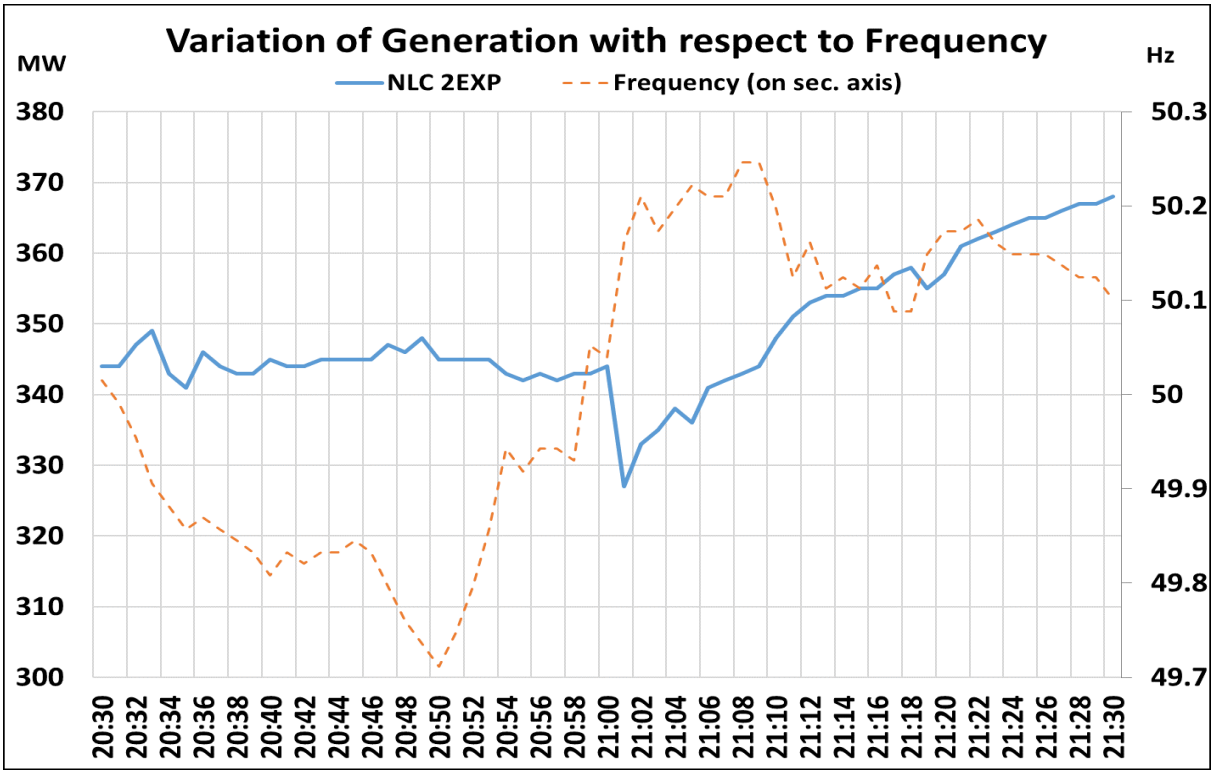
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
MW
Hz
NLC 2EXP
Frequency (on sec. axis)
380
370
360
350
340
330
320
310
300
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
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21:14
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21:18
21:20
21:22
21:24
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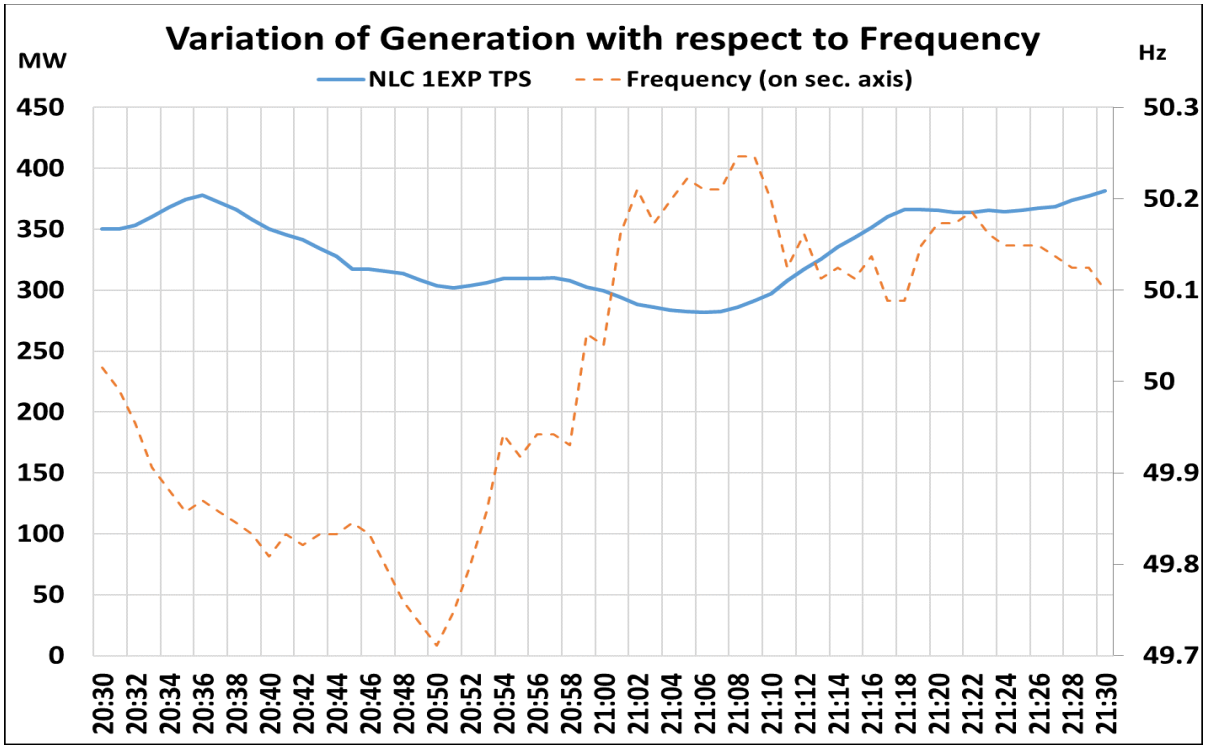
21:28
21:30


Variation of Generation with respect to Frequency
MW
Hz
NLC 1EXP TPS
Frequency (on sec. axis)
450
400
350
300
250
200
150
100
50
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
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20:50
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21:28
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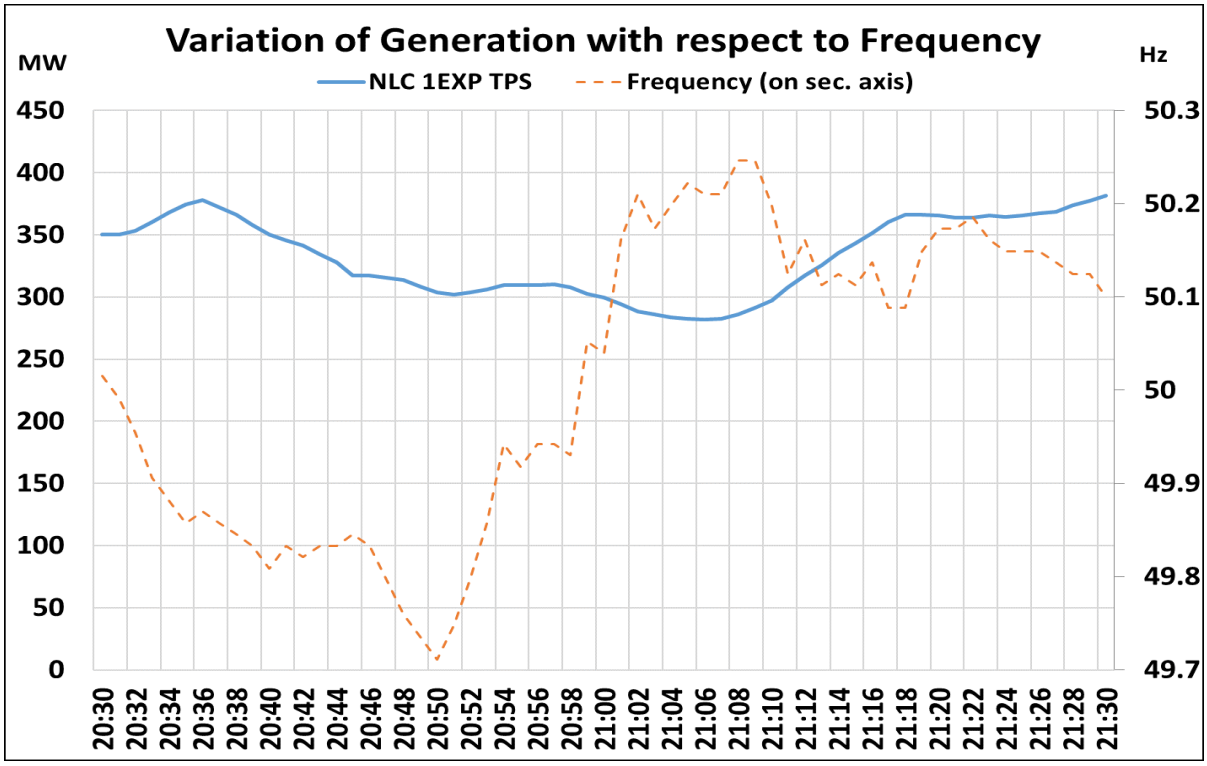
Variation of Generation with respect to Frequency
MW
Hz
NLC 1EXP TPS
Frequency (on sec. axis)
450
400
350
300
250
200
150
100
50
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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21:12
21:14
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21:18
21:20
21:22
21:24
21:26
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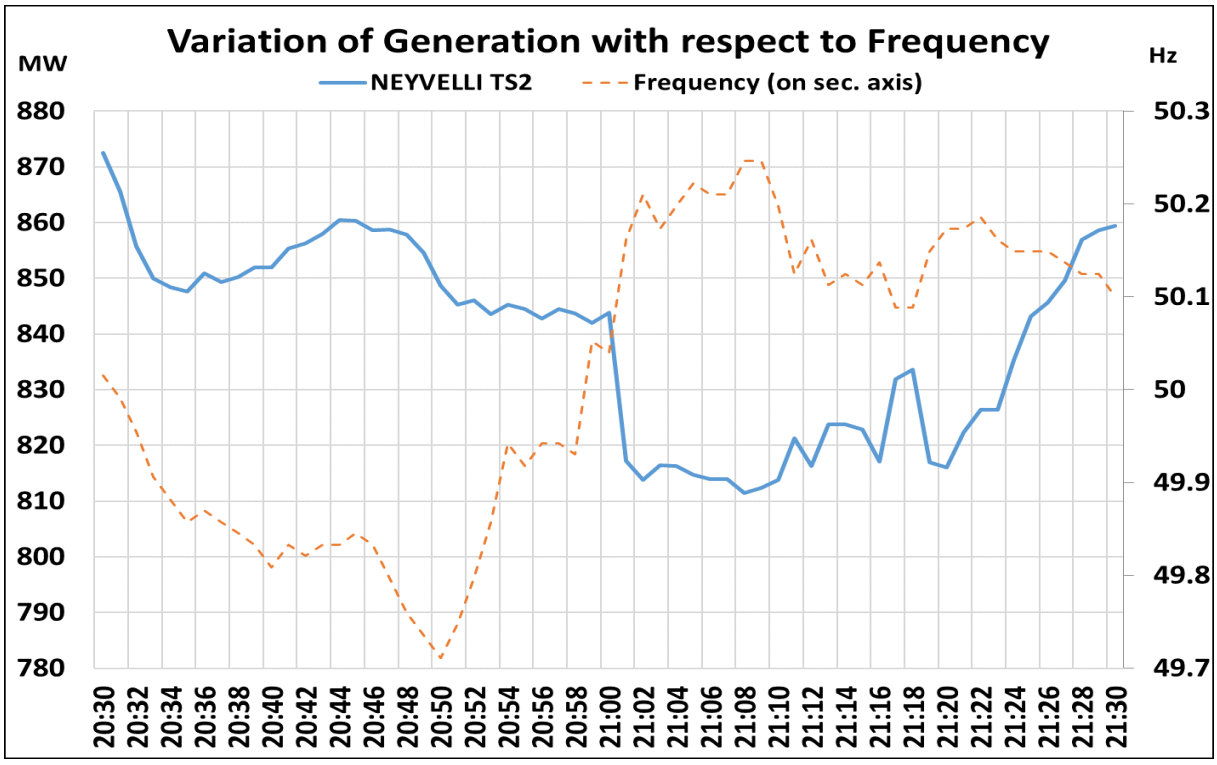
21:30


Variation of Generation with respect to Frequency
MW
Hz
NEYVELLI TS2
Frequency (on sec. axis)
880
870
860
850
840
830
820
810
800
790
780
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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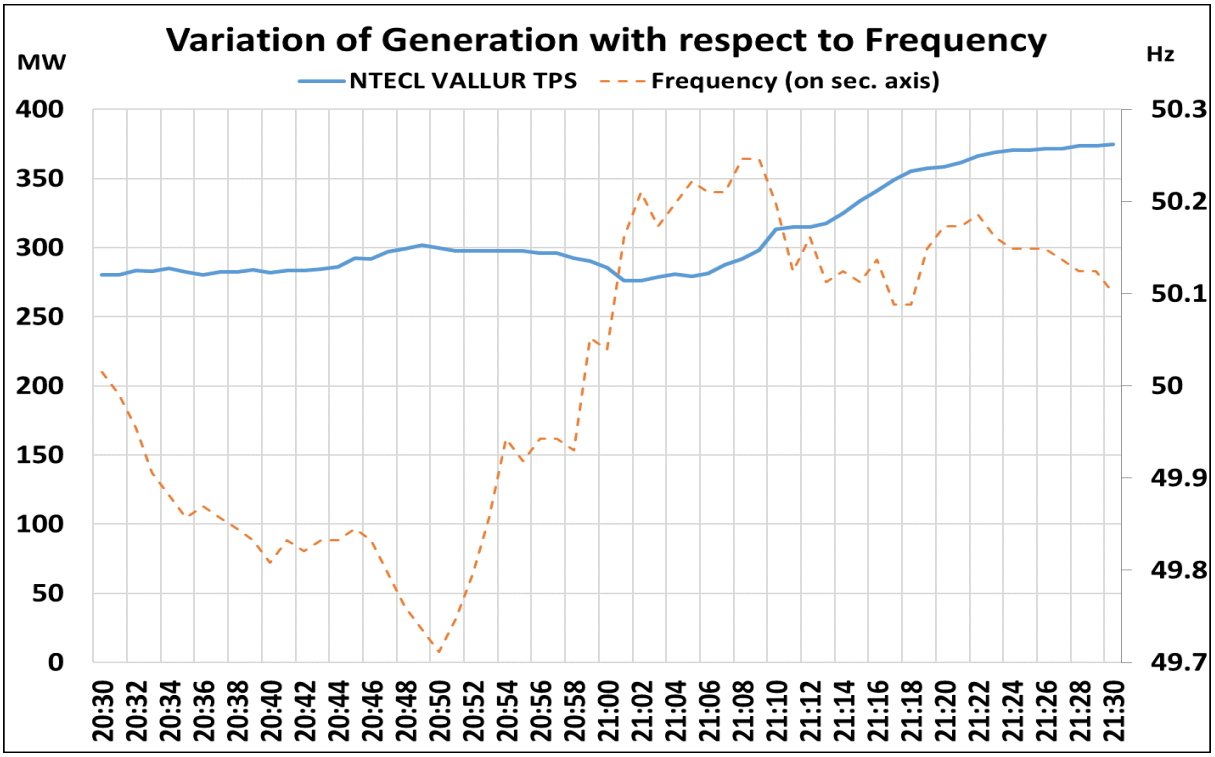
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
MW
Hz
NTECL VALLUR TPS
Frequency (on sec. axis)
400
350
300
250
200
150
100
50
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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21:14
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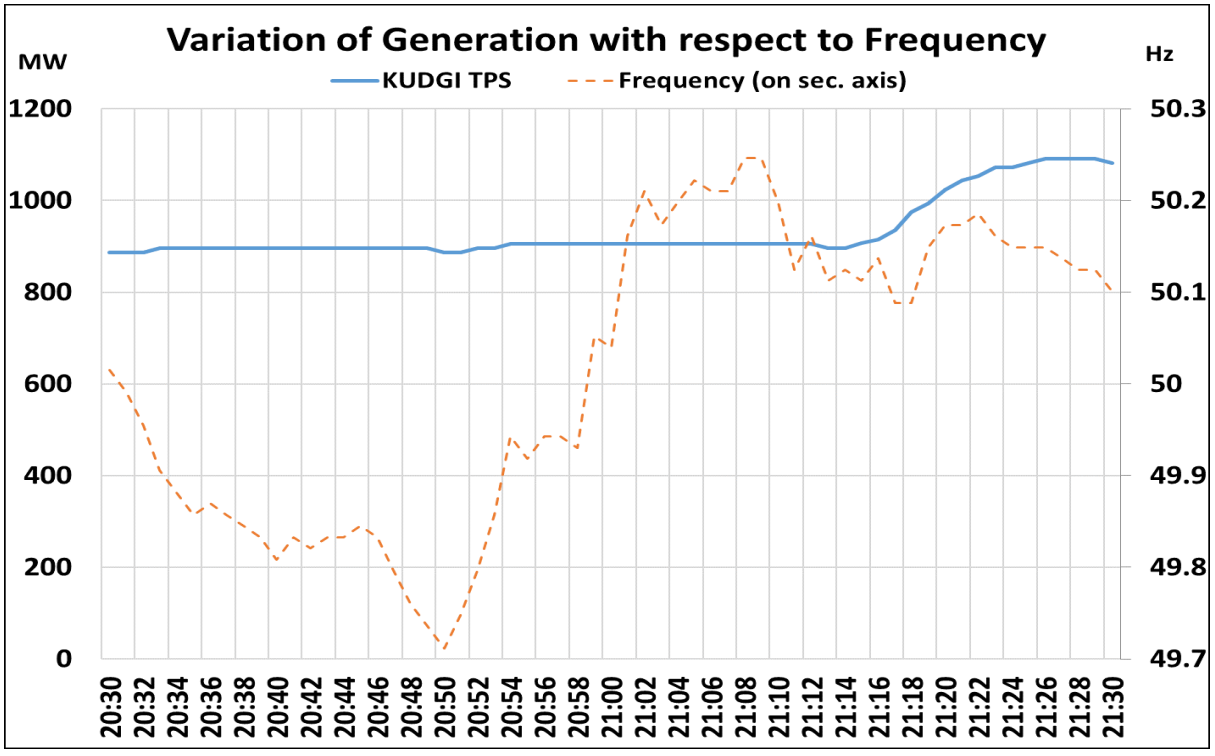
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
MW
Hz
KUDGI TPS
Frequency (on sec. axis)
1200
1000
800
600
400
200
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
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21:22
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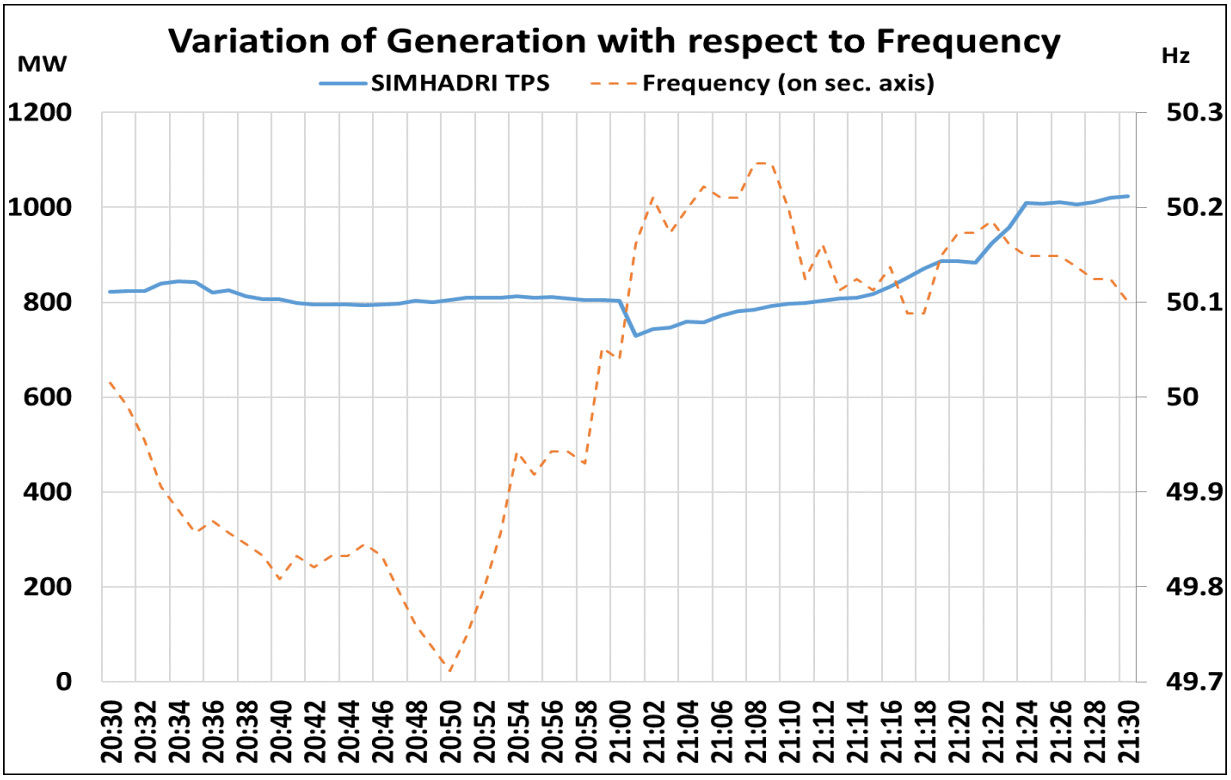
21:30


Variation of Generation with respect to Frequency
MW
Hz
SIMHADRI TPS
Frequency (on sec. axis)
1200
1000
800
600
400
200
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
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21:14
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21:18
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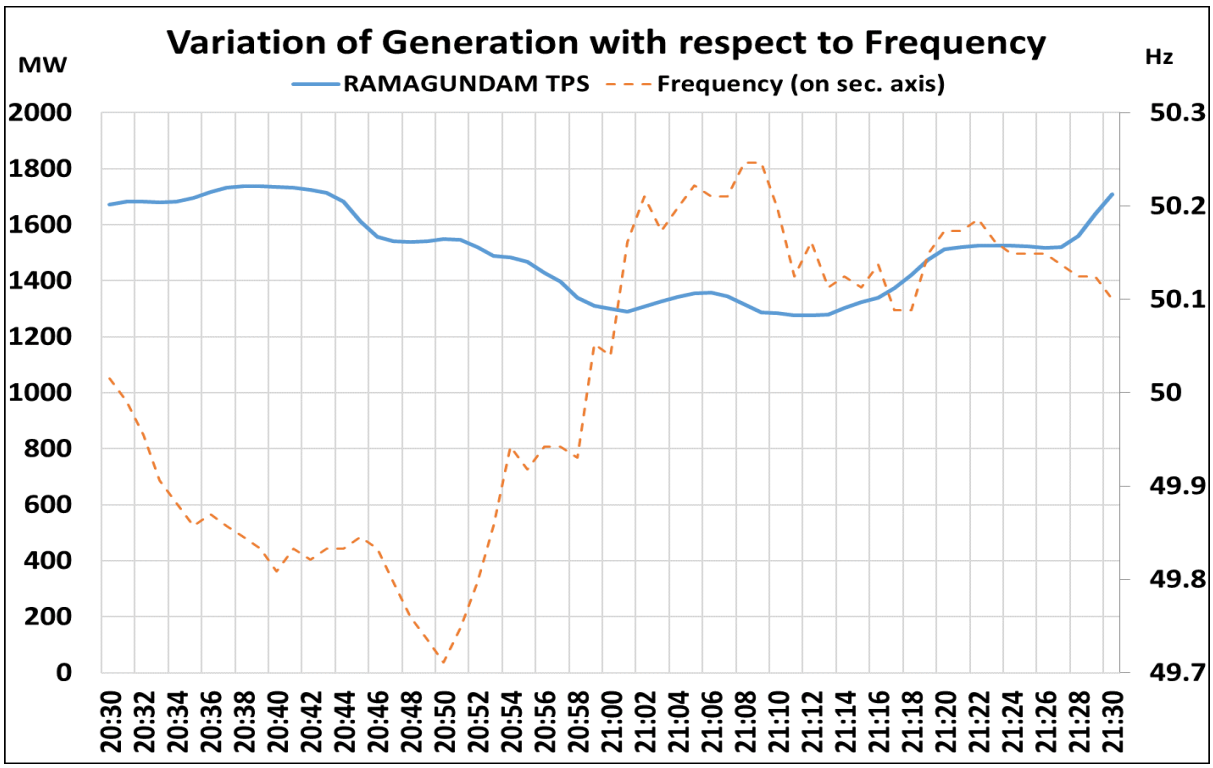
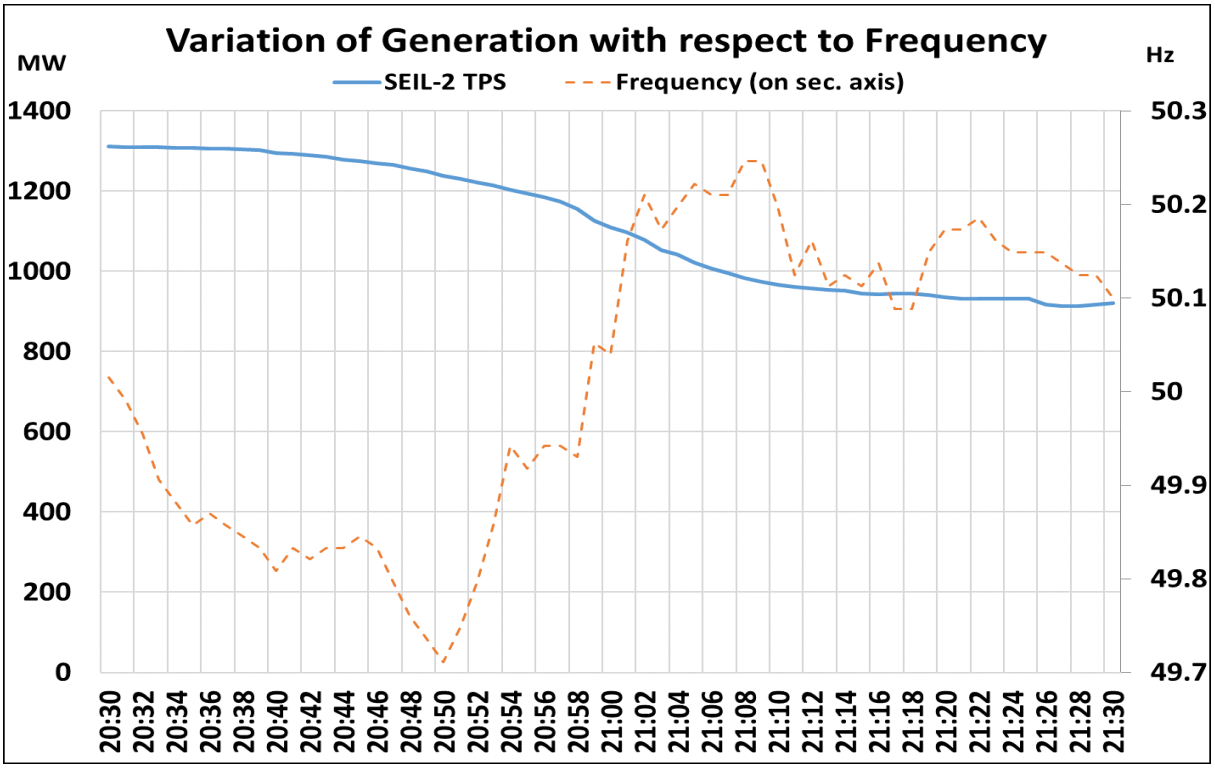
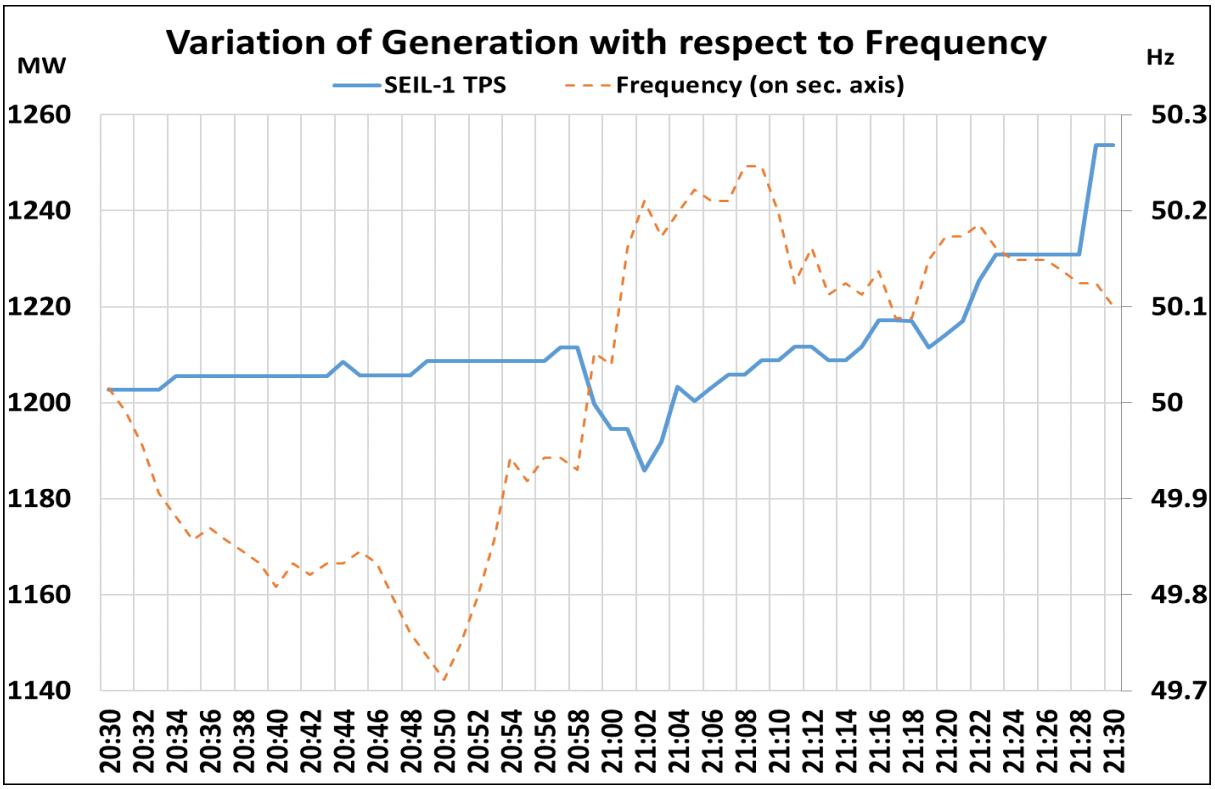
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
MW
Hz
RAMAGUNDAM TPS
Frequency (on sec. axis)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
MW
Hz
SEIL-2 TPS
Frequency (on sec. axis)
1400
1200
1000
800
600
400
200
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
MW
Hz
SEIL-1 TPS
Frequency (on sec. axis)
1260
1240
1220
1200
1180
1160
1140
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
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21:12
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21:16
21:18
21:20
21:22
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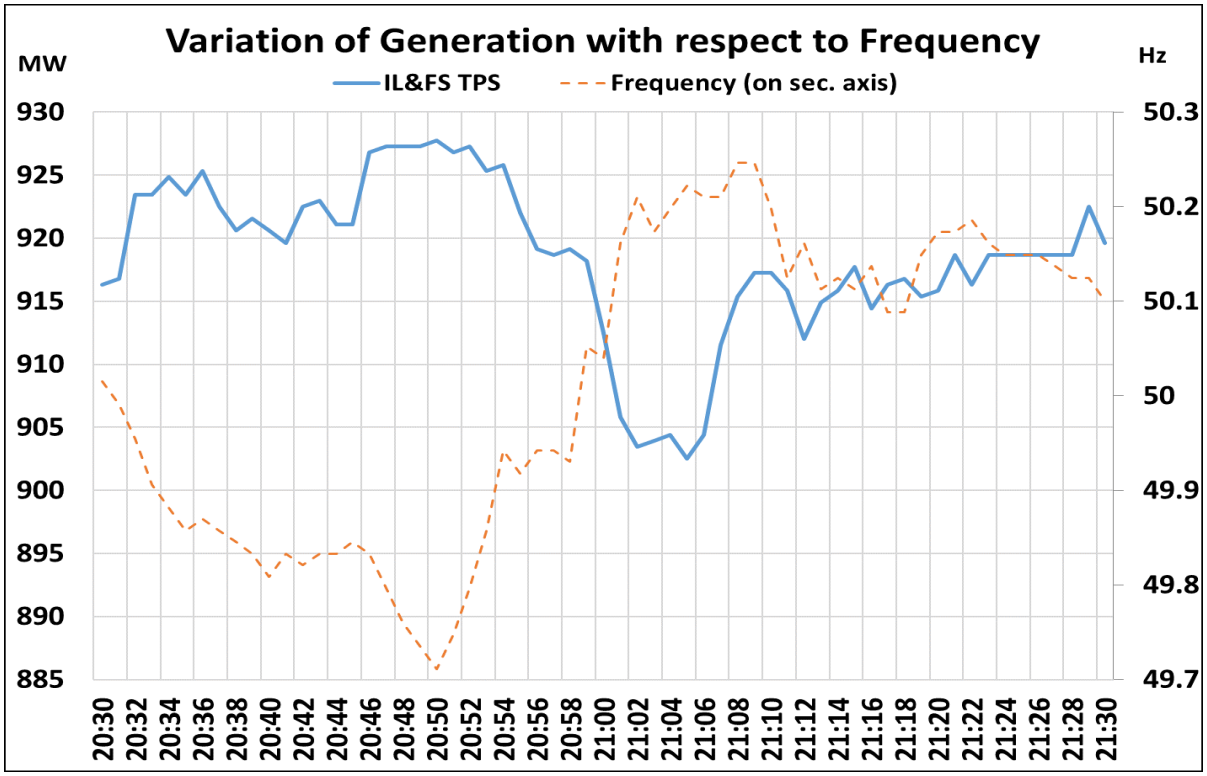
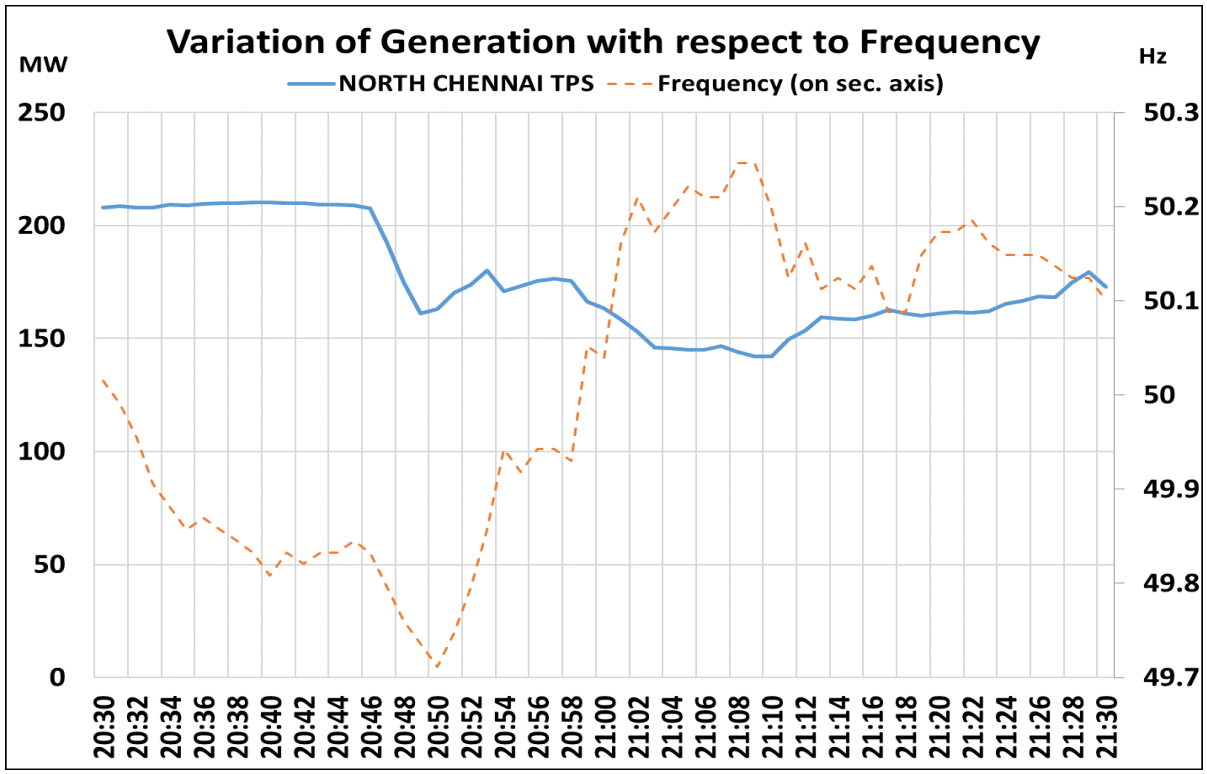
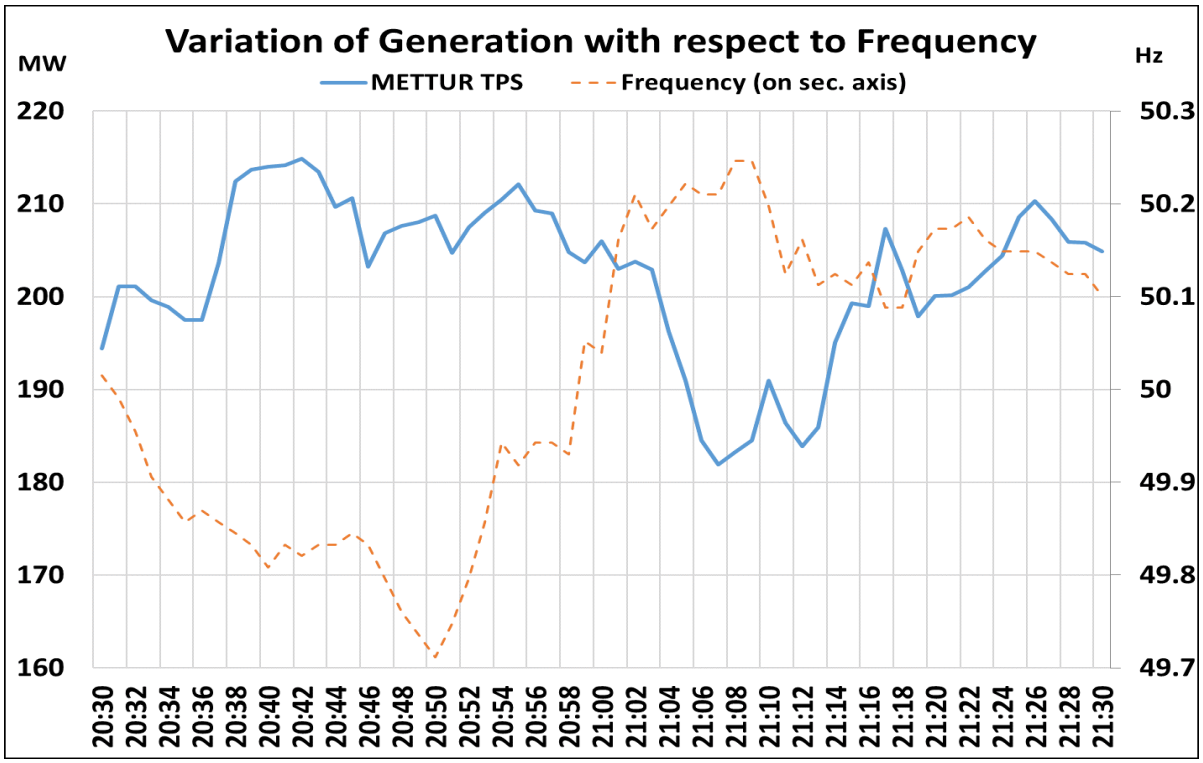
21:26
21:28
21:30


Variation of Generation with respect to Frequency
MW
Hz
IL&FS TPS
Frequency (on sec. axis)
930
925
920
915
910
905
900
895
890
885
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
MW
Hz
NORTH CHENNAI TPS
Frequency (on sec. axis)
250
200
150
100
50
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
MW
Hz
METTUR TPS
Frequency (on sec. axis)
220
210
200
190
180
170
160
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
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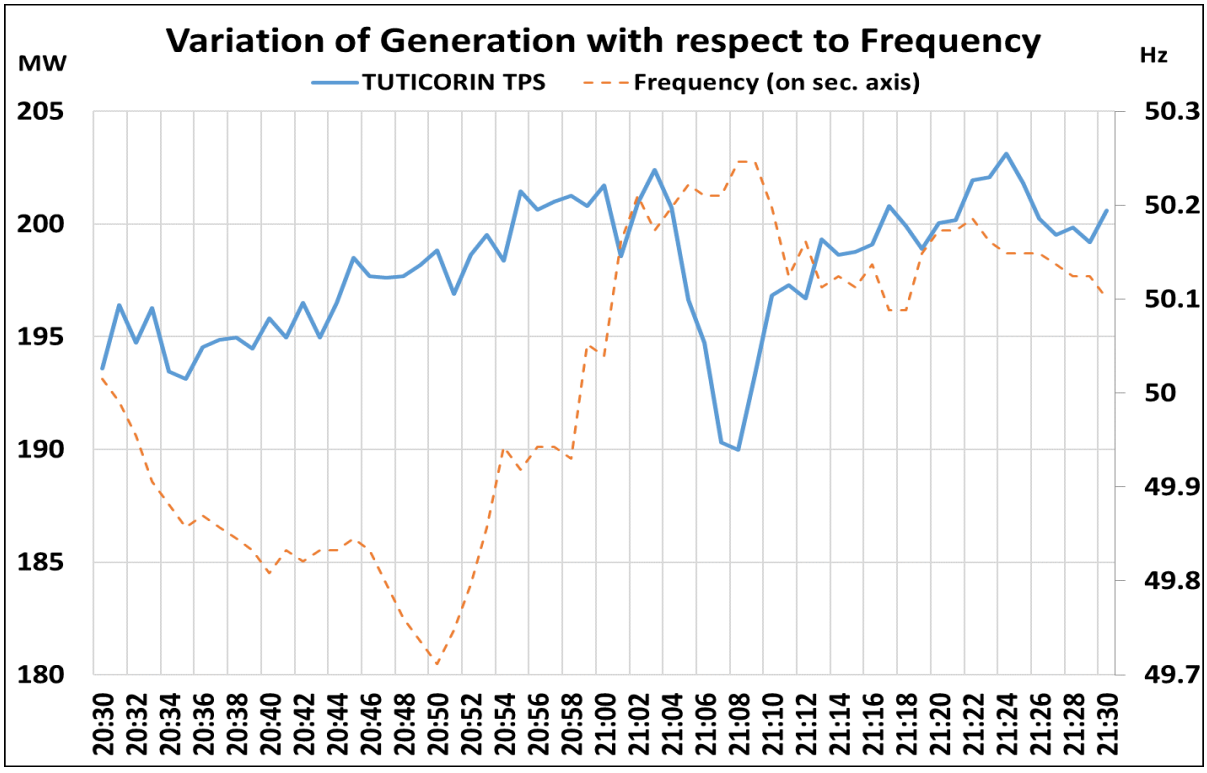
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
MW
Hz
TUTICORIN TPS
Frequency (on sec. axis)
205
200
195
190
185
180
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
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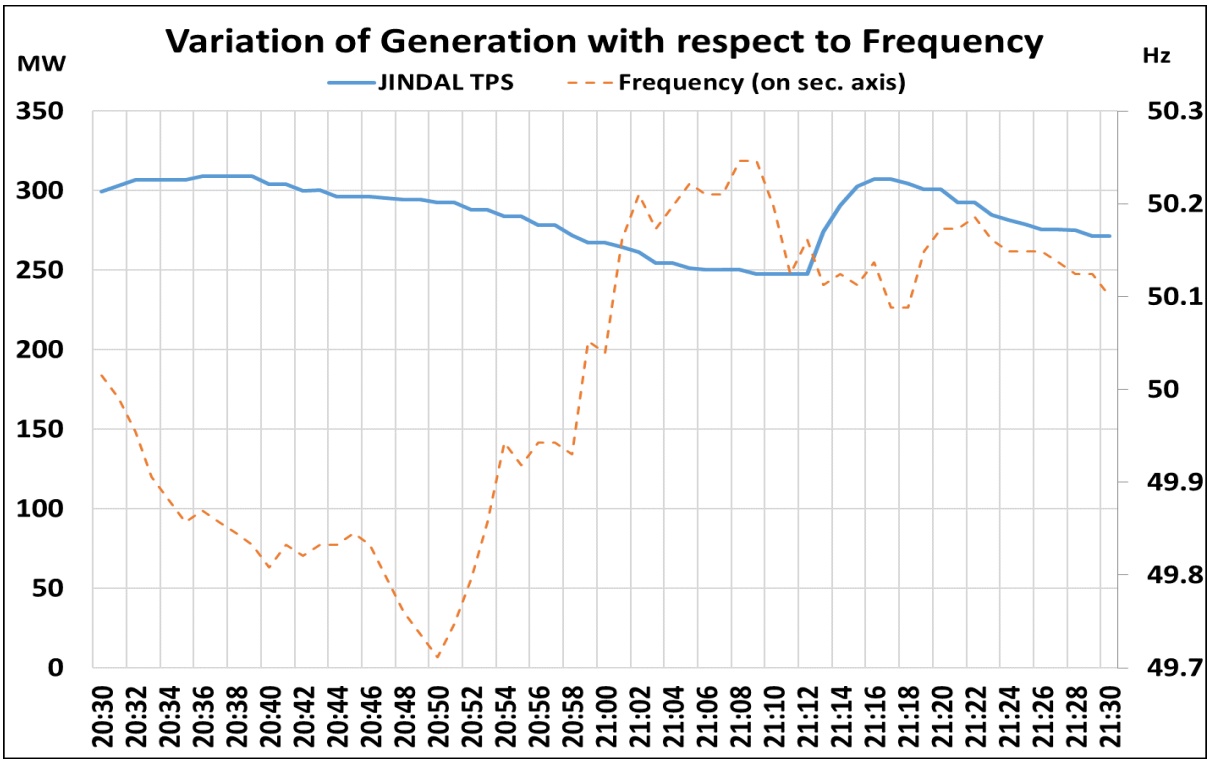
Variation of Generation with respect to Frequency
MW
Hz
JINDAL TPS
Frequency (on sec. axis)
350
300
250
200
150
100
50
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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21:22
21:24
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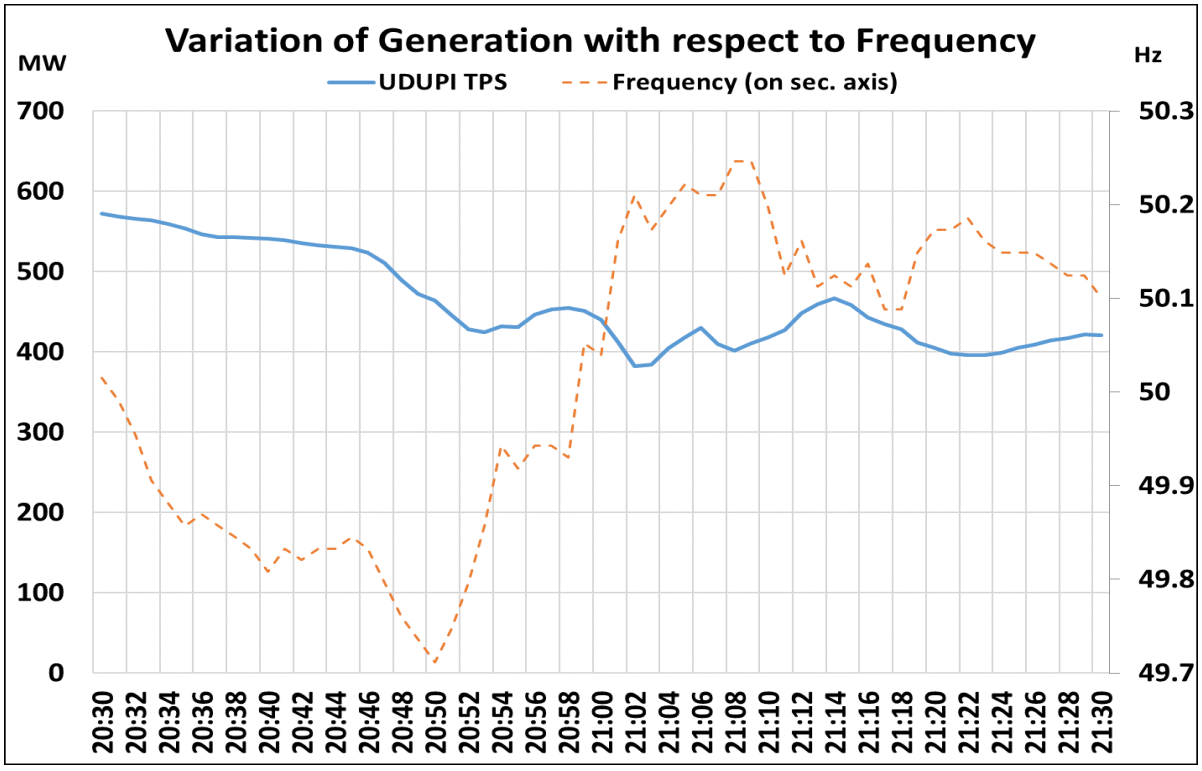
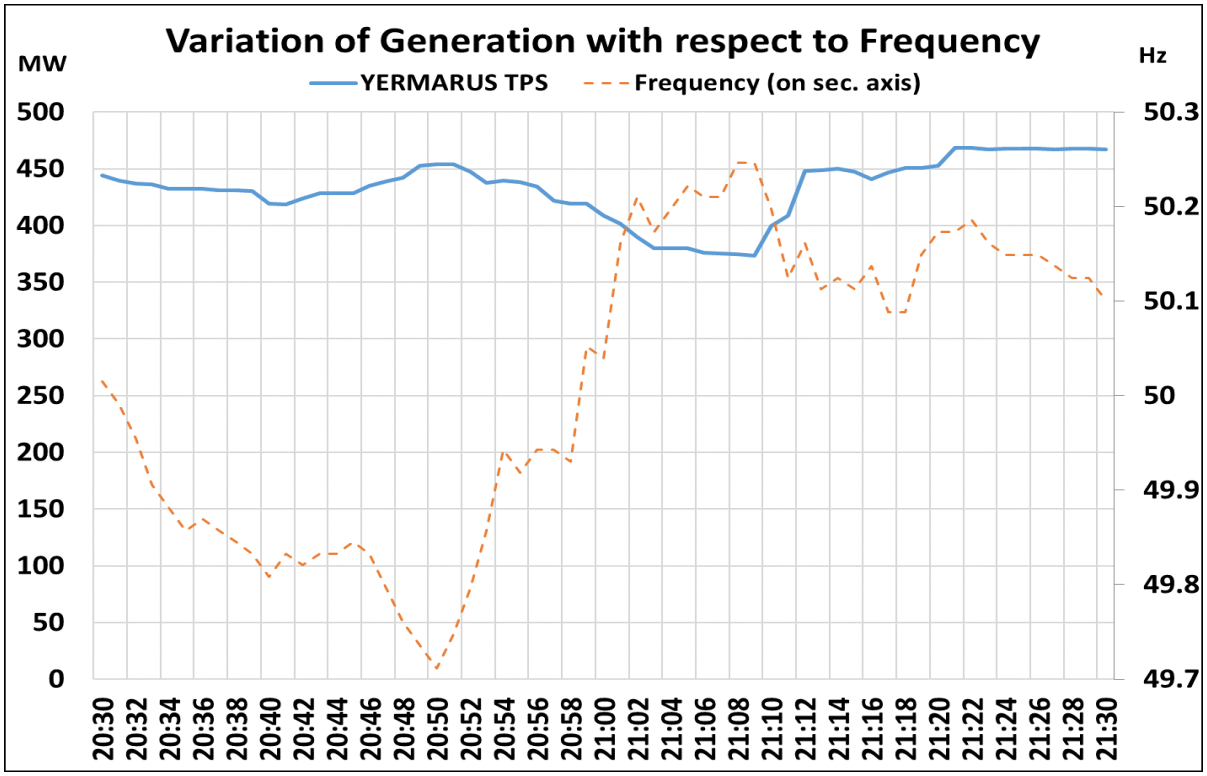
21:28
21:30


Variation of Generation with respect to Frequency
MW
Hz
UDUPI TPS
Frequency (on sec. axis)
700
600
500
400
300
200
100
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
MW
Hz
YERMARUS TPS
Frequency (on sec. axis)
500
450
400
350
300
250
200
150
100
50
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
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21:14
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21:18
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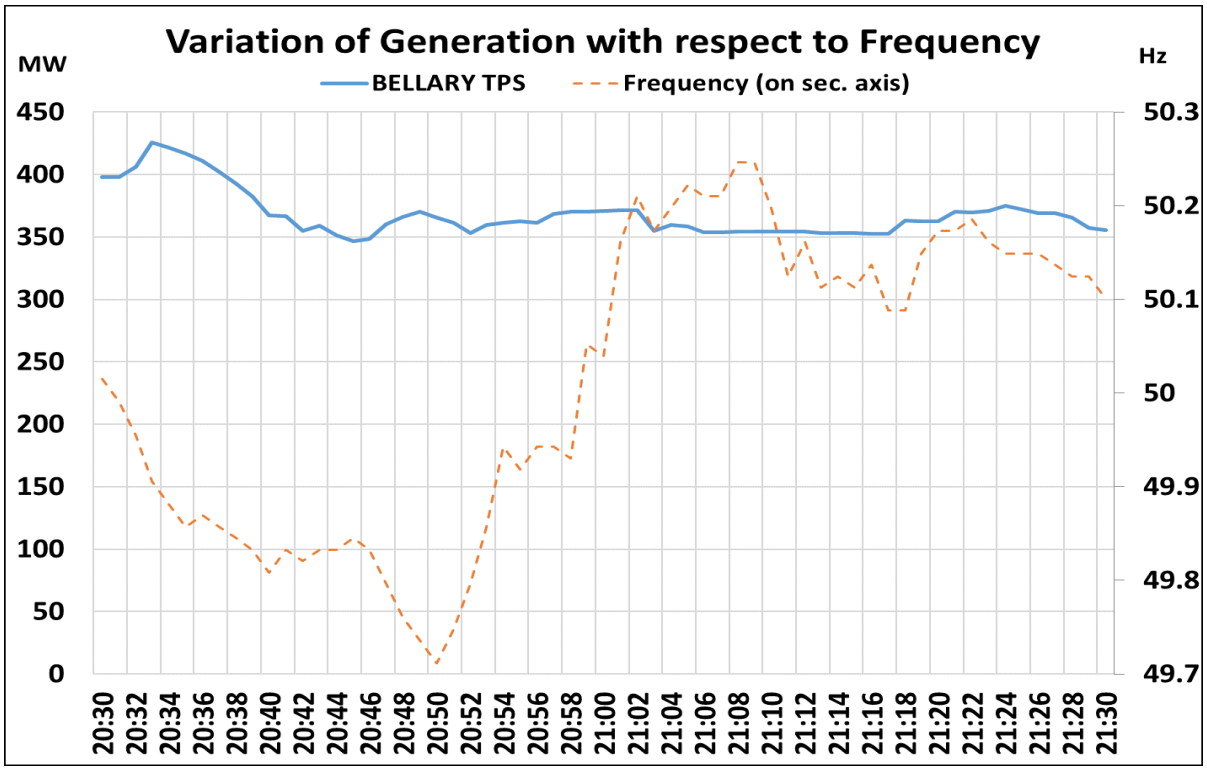
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
MW
Hz
BELLARY TPS
Frequency (on sec. axis)
450
400
350
300
250
200
150
100
50
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
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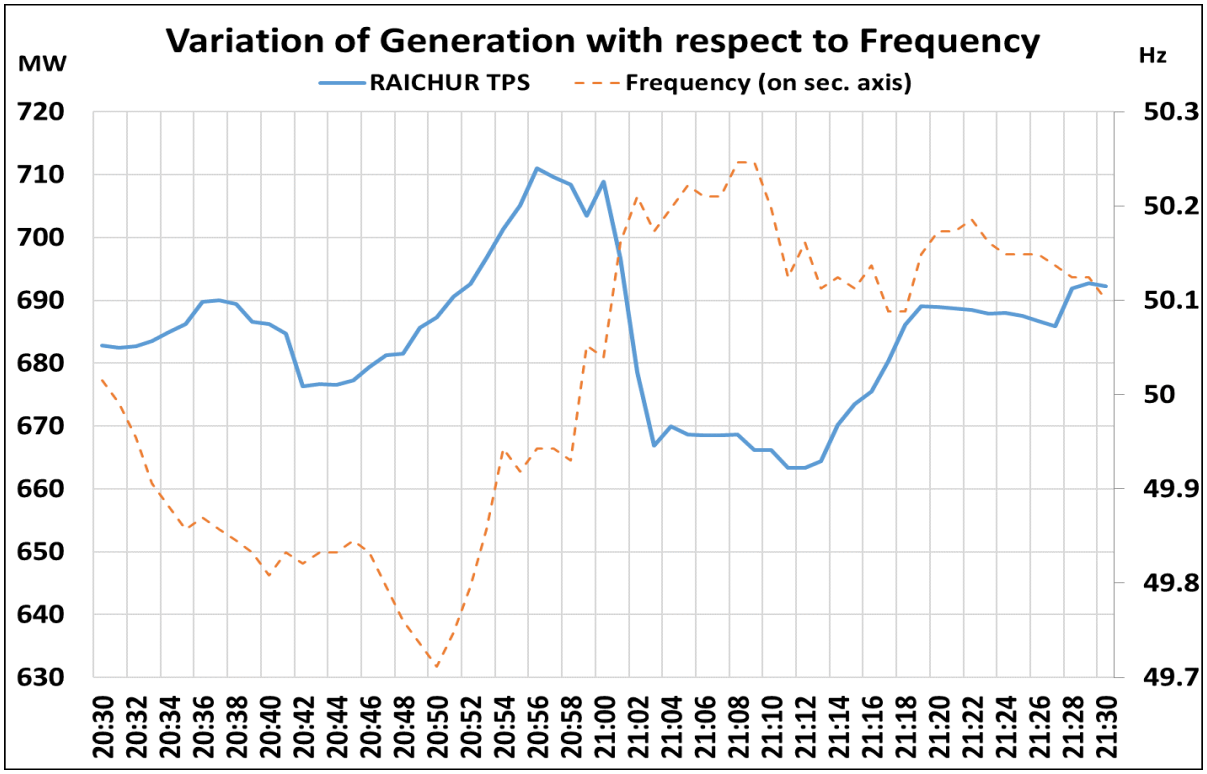
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
MW
Hz
RAICHUR TPS
Frequency (on sec. axis)
720
710
700
690
680
670
660
650
640
630
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
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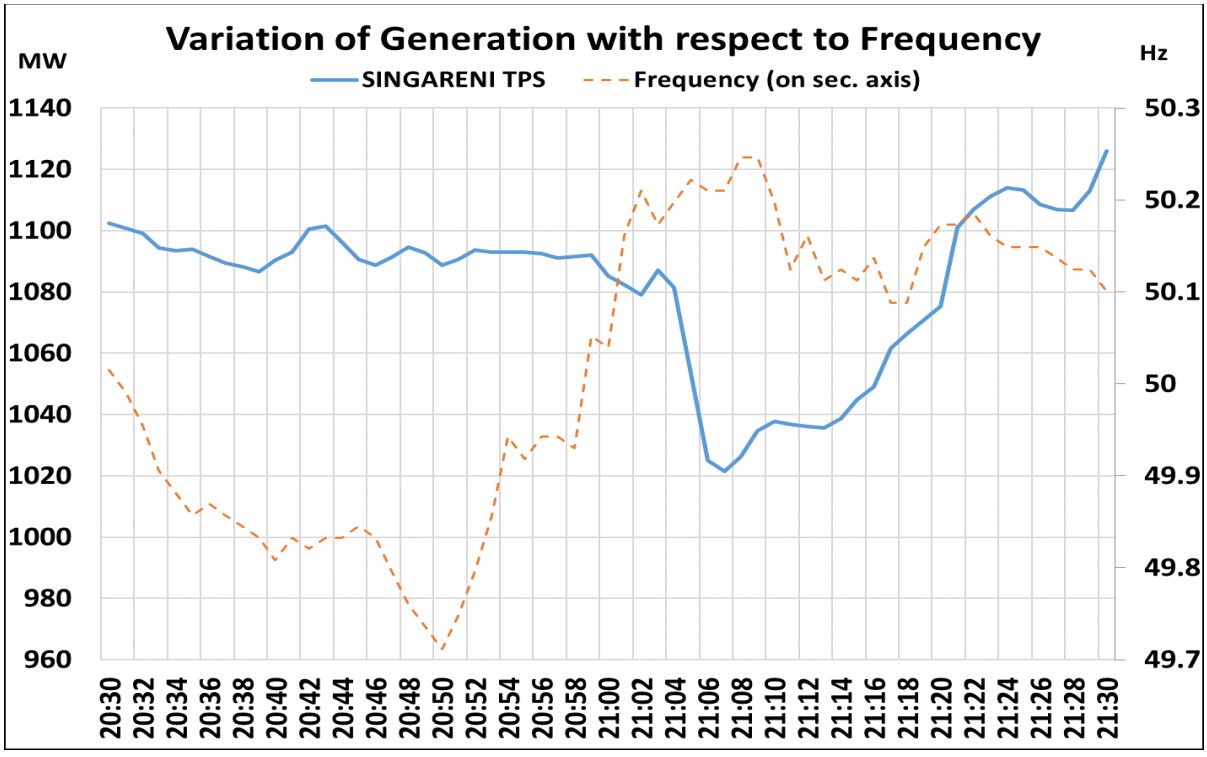
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
MW
Hz
SINGARENI TPS
Frequency (on sec. axis)
1140
1120
1100
1080
1060
1040
1020
1000
980
960
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
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21:14
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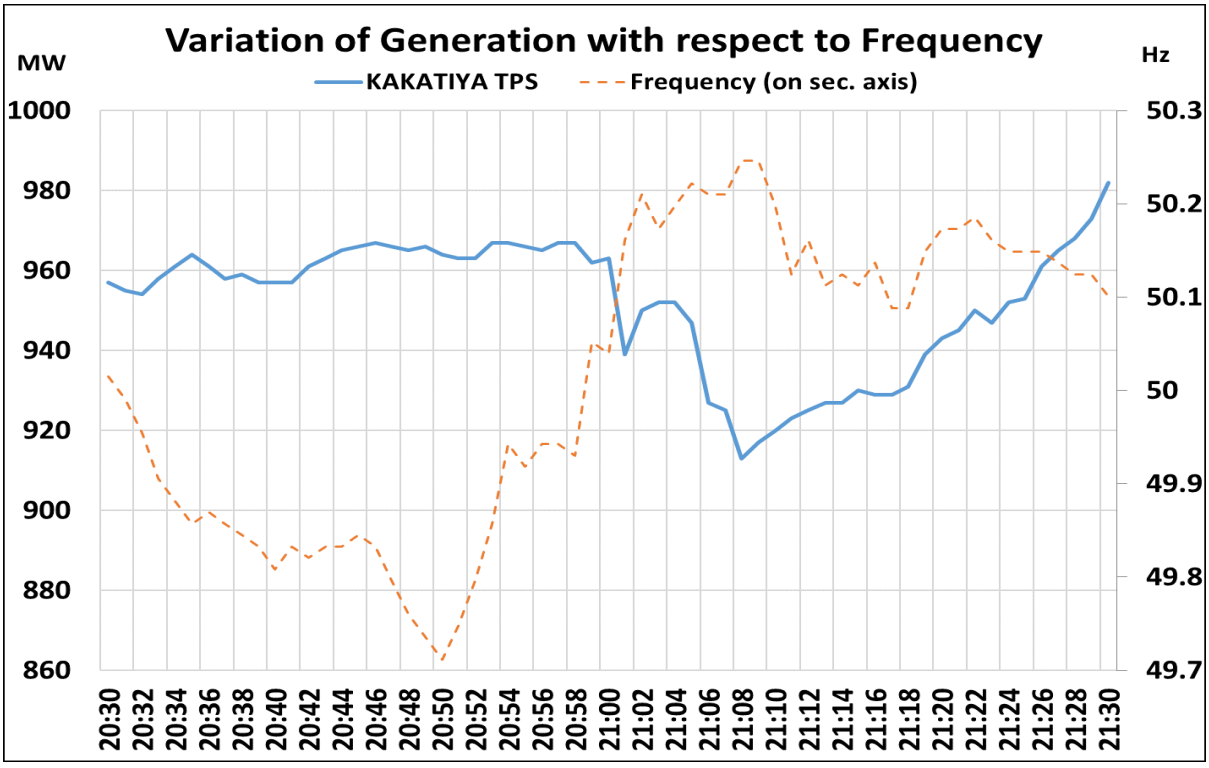
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
MW
Hz
KAKATIYA TPS
Frequency (on sec. axis)
1000
980
960
940
920
900
880
860
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
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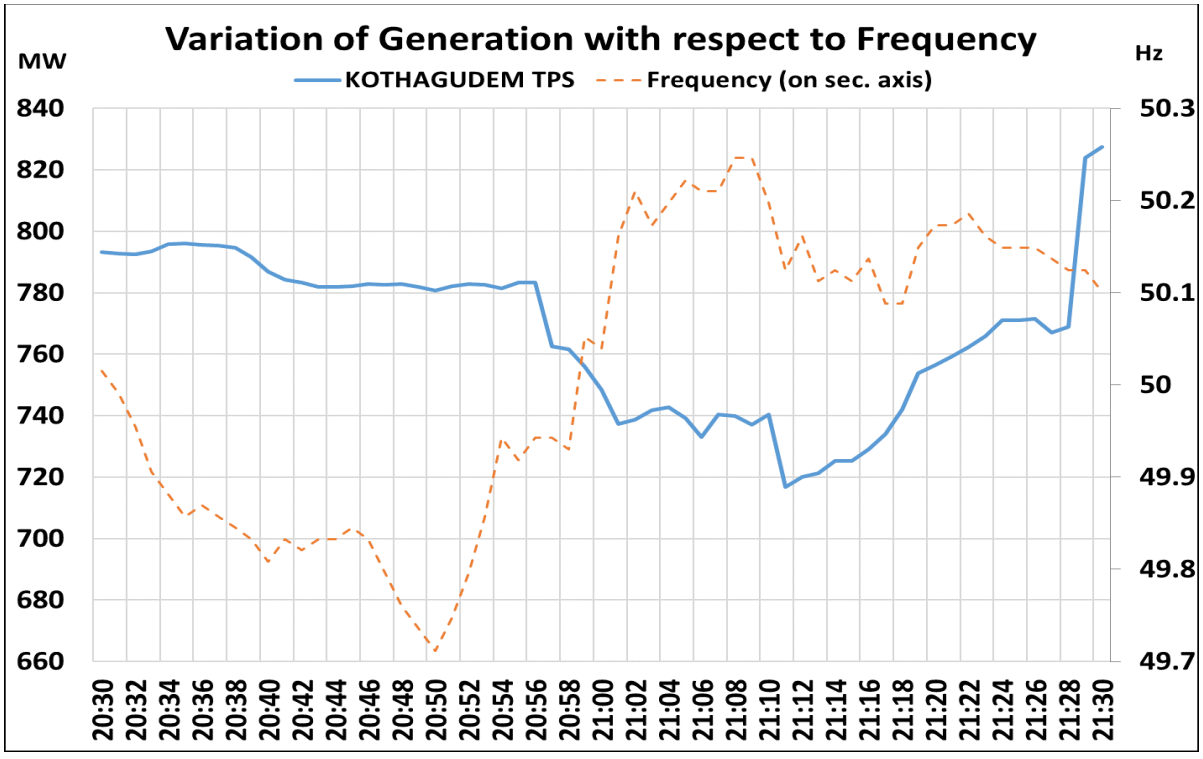
21:28
21:30


Variation of Generation with respect to Frequency
MW
Hz
KOTHAGUDEM TPS
Frequency (on sec. axis)
840
820
800
780
760
740
720
700
680
660
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
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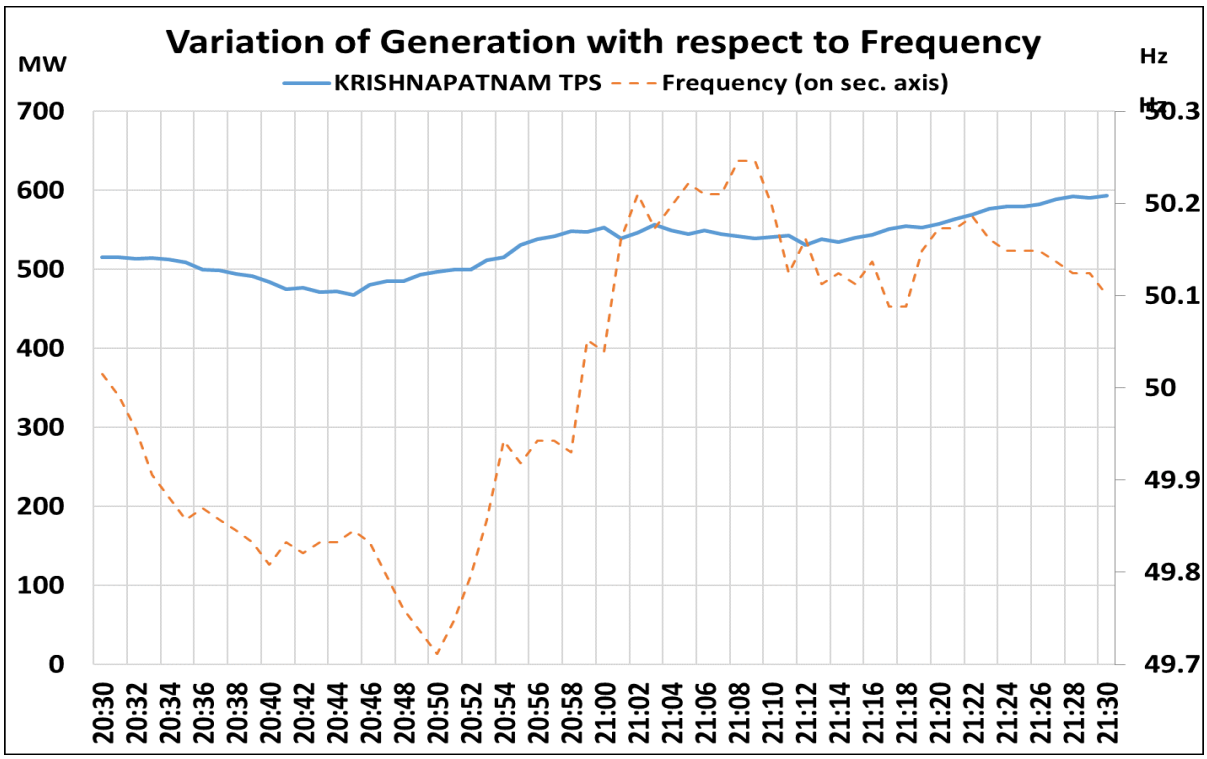
Variation of Generation with respect to Frequency
MW
Hz
KRISHNAPATNAM TPS
Frequency (on sec. axis)
700
600
500
400
300
200
100
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
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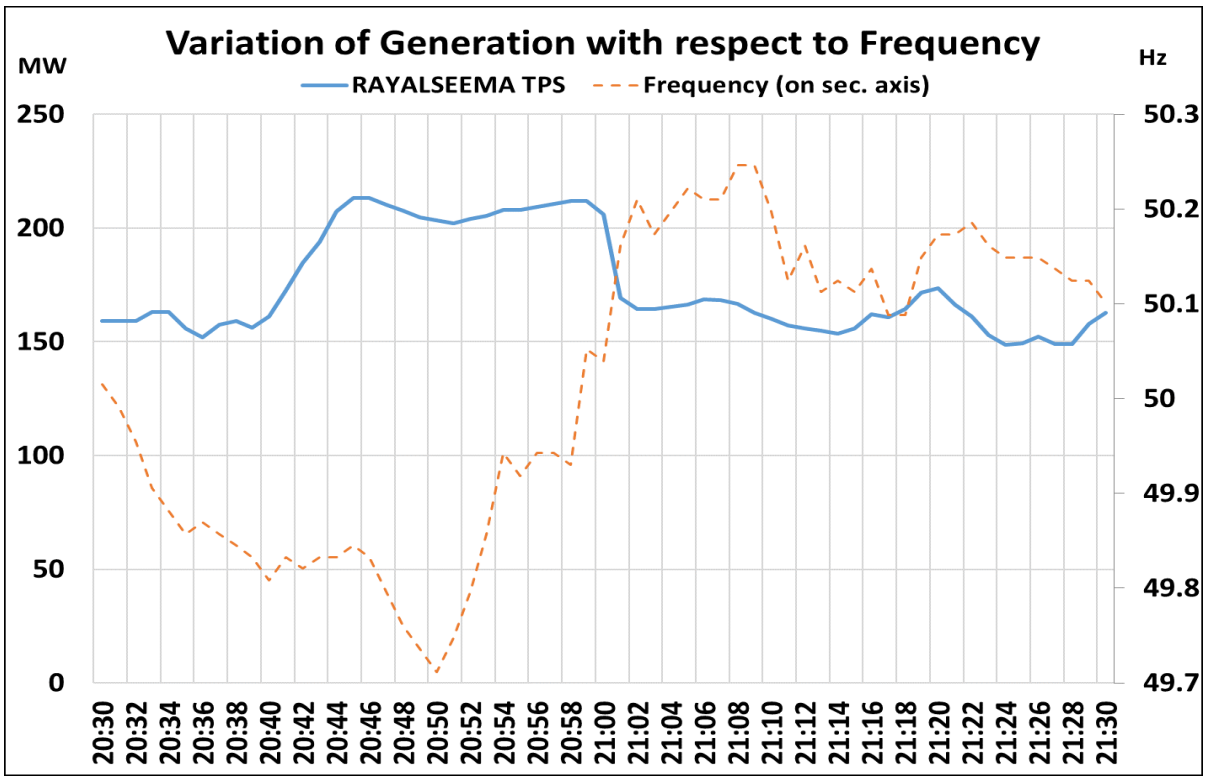
Variation of Generation with respect to Frequency
MW
Hz
RAYALSEEMA TPS
Frequency (on sec. axis)
250
200
150
100
50
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
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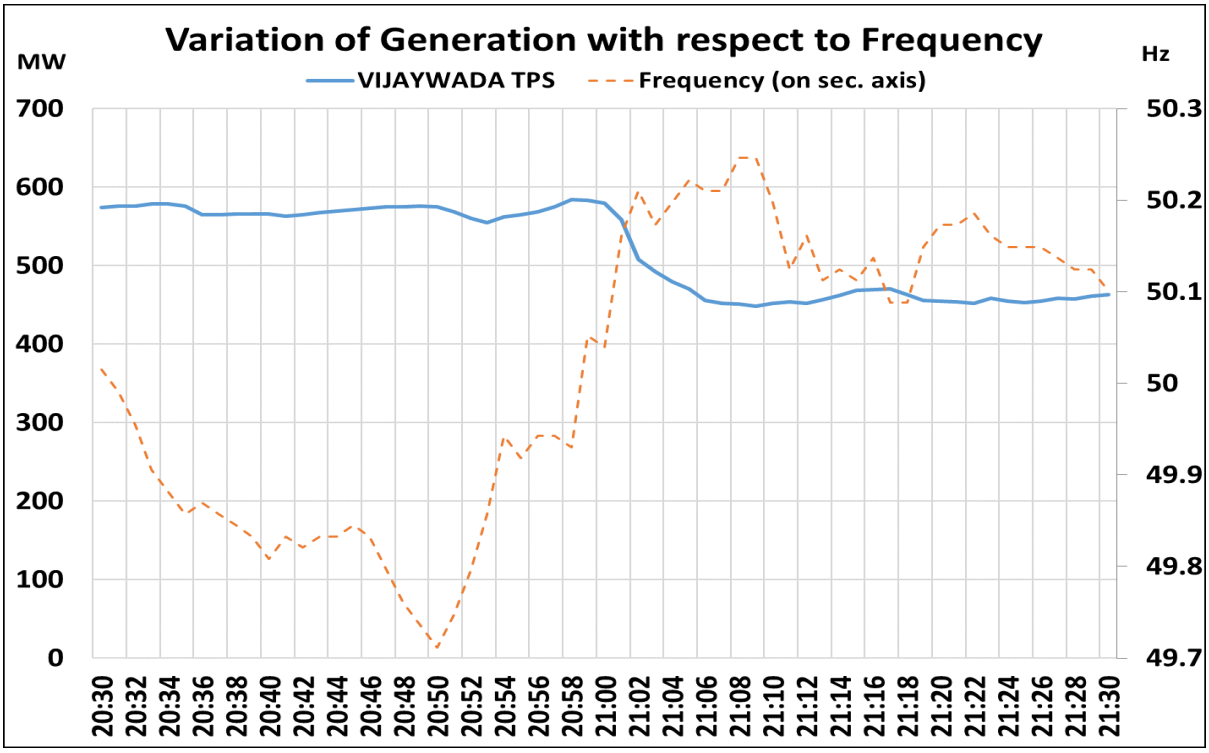
Variation of Generation with respect to Frequency
MW
Hz
VIJAYWADA TPS
Frequency (on sec. axis)
700
600
500
400
300
200
100
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
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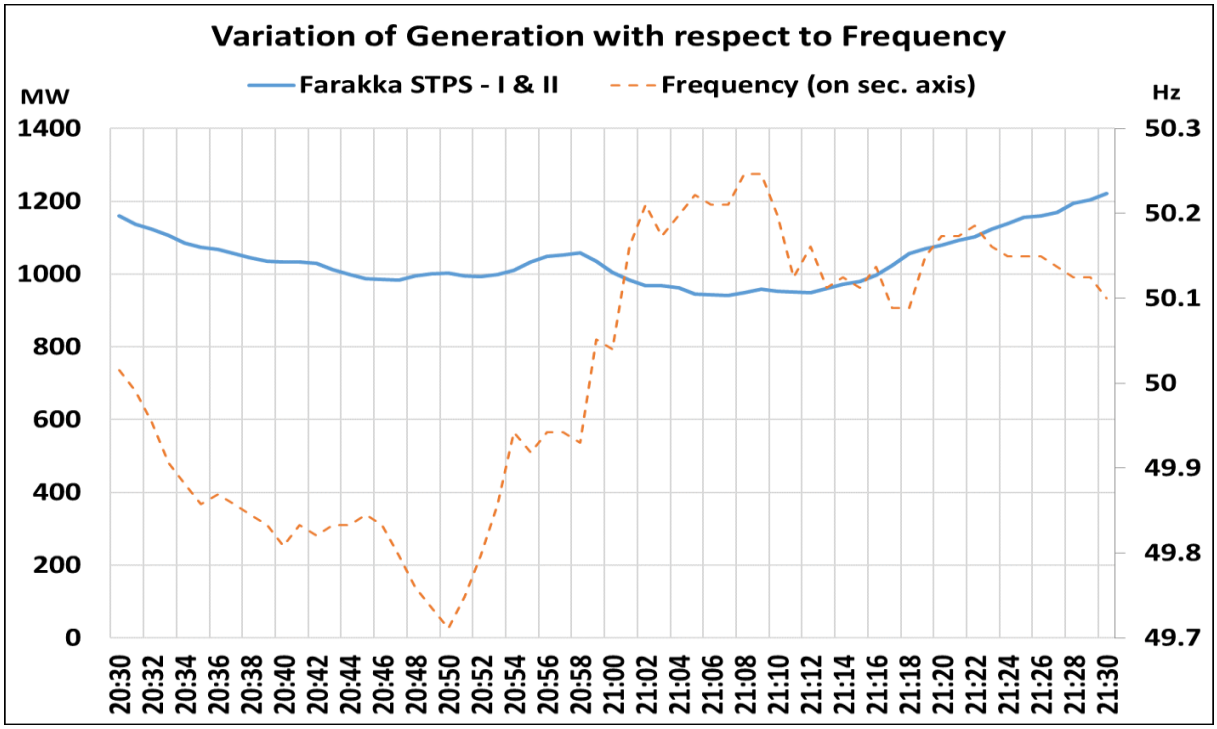
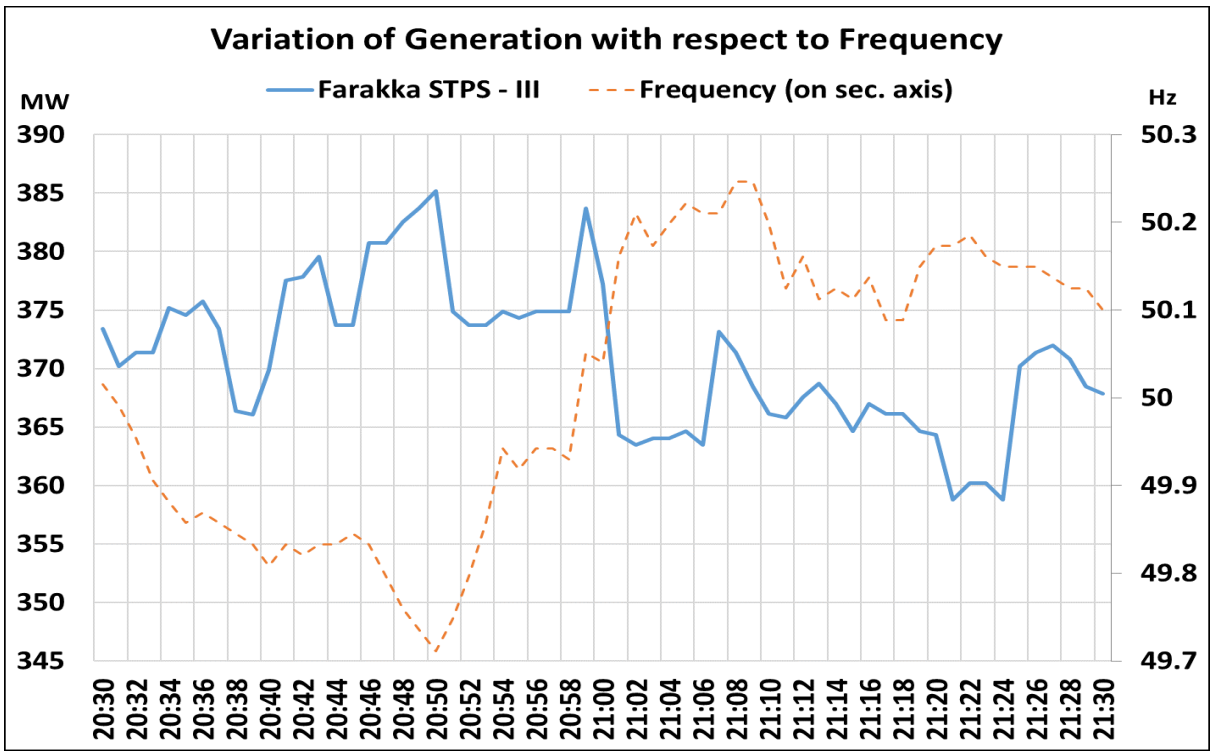
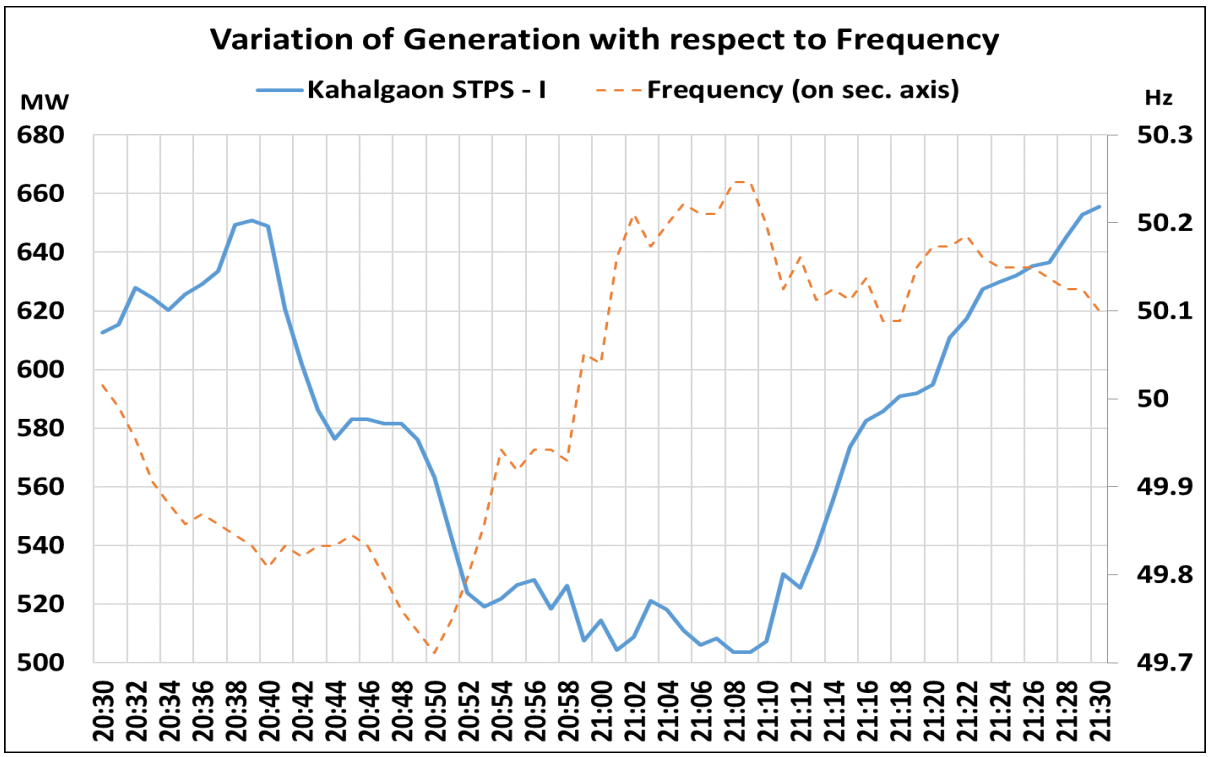
21:28
21:30

Eastern Region






Variation of Generation with respect to Frequency
Kahalgaon STPS - I
Frequency (on sec. axis)
MW
Hz
680
660
640
620
600
580
560
540
520
500
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
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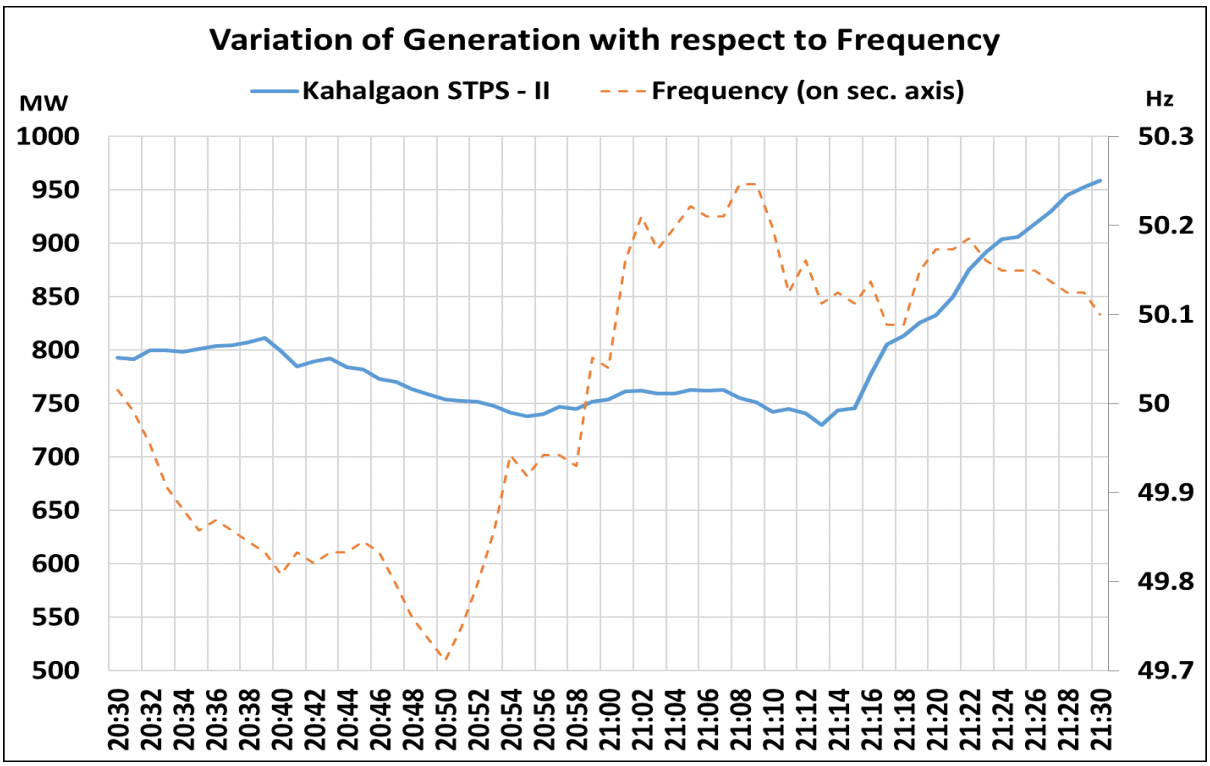
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Kahalgaon STPS - II
Frequency (on sec. axis)
MW
Hz
1000
950
900
850
800
750
700
650
600
550
500
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
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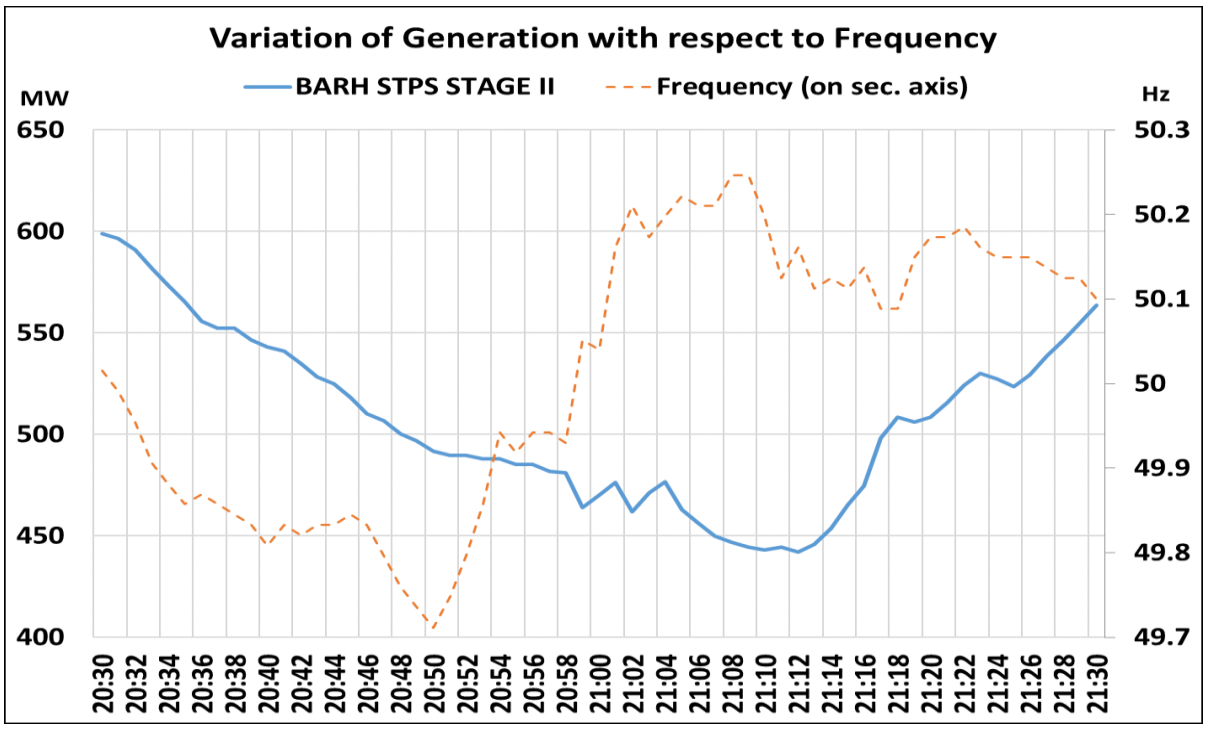
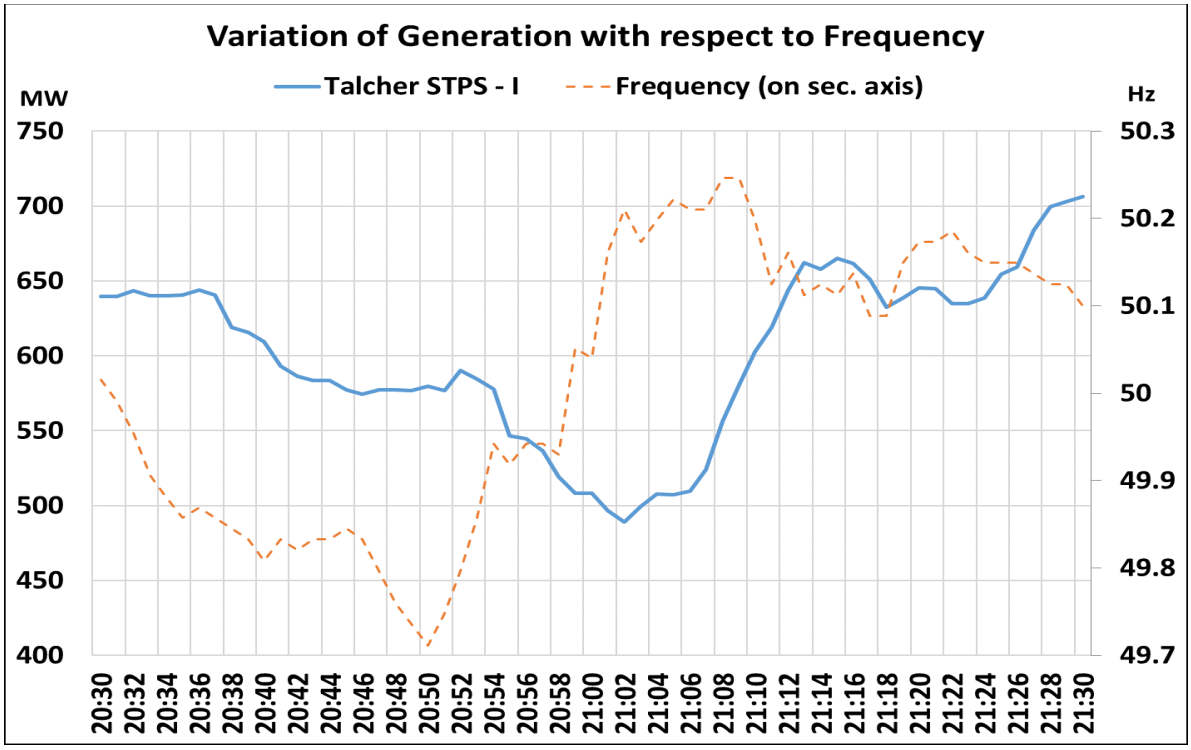
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
BARH STPS STAGE II
Frequency (on sec. axis)
MW
Hz
650
600
550
500
450
400
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Talcher STPS - I
Frequency (on sec. axis)
MW
Hz
750
700
650
600
550
500
450
400
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
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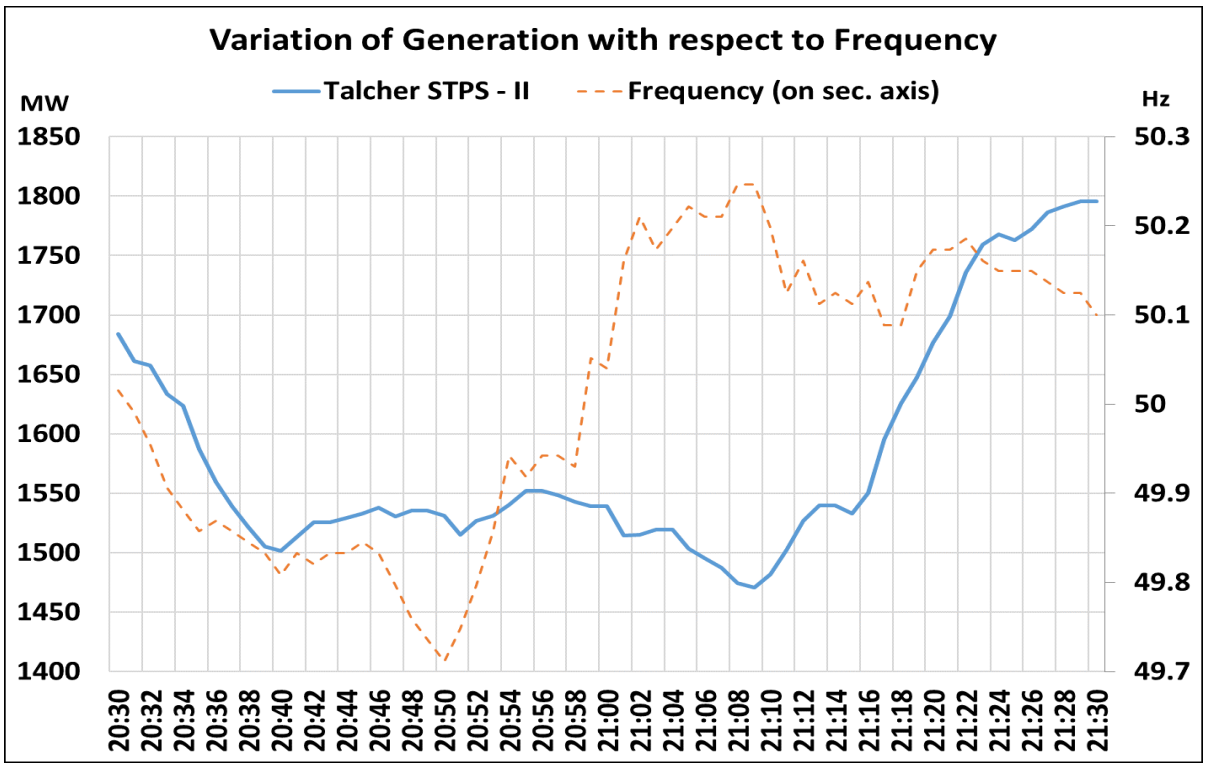
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Talcher STPS - II
Frequency (on sec. axis)
MW
Hz
1850
1800
1750
1700
1650
1600
1550
1500
1450
1400
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
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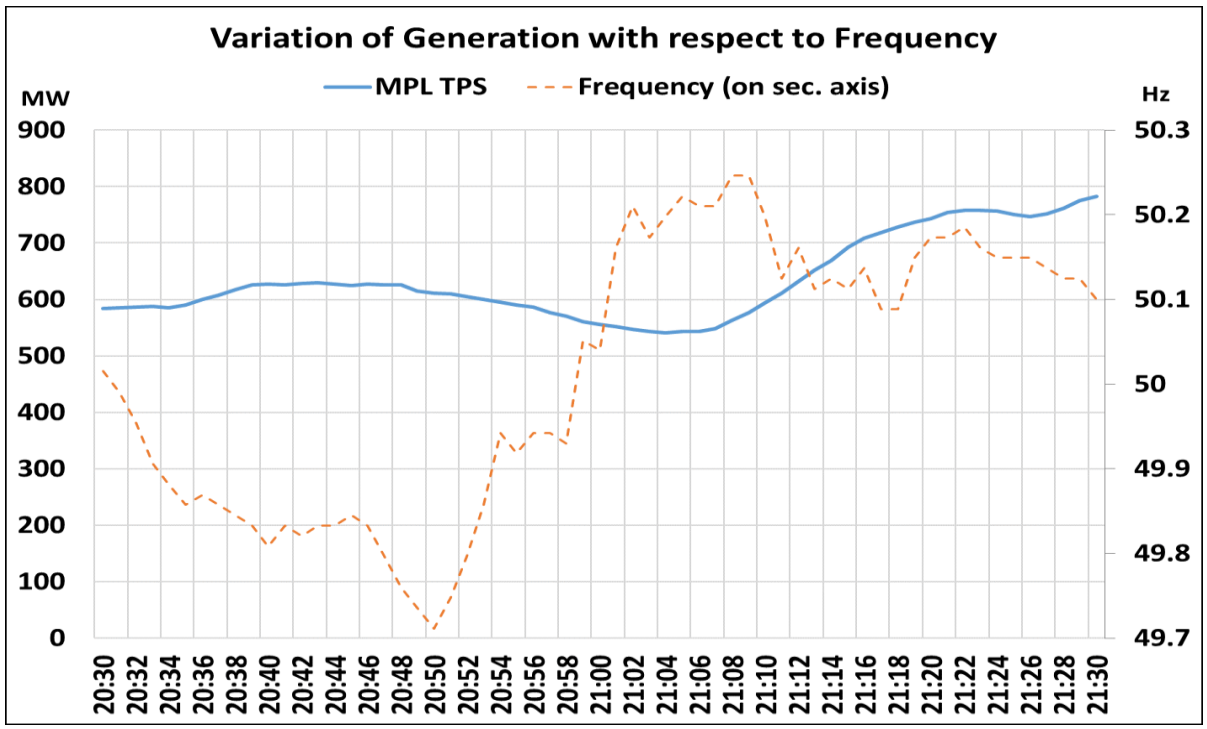
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
MPL TPS
Frequency (on sec. axis)
MW
Hz
900
800
700
600
500
400
300
200
100
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
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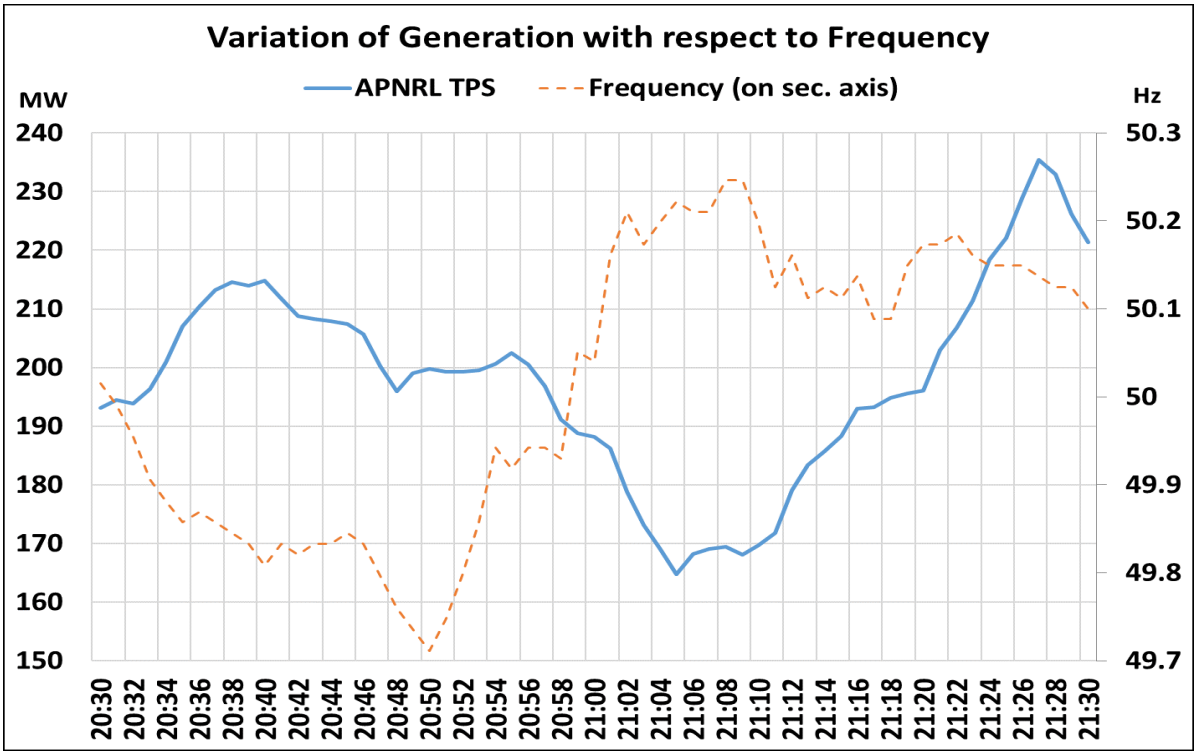
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
APNRL TPS
Frequency (on sec. axis)
MW
Hz
240
230
220
210
200
190
180
170
160
150
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
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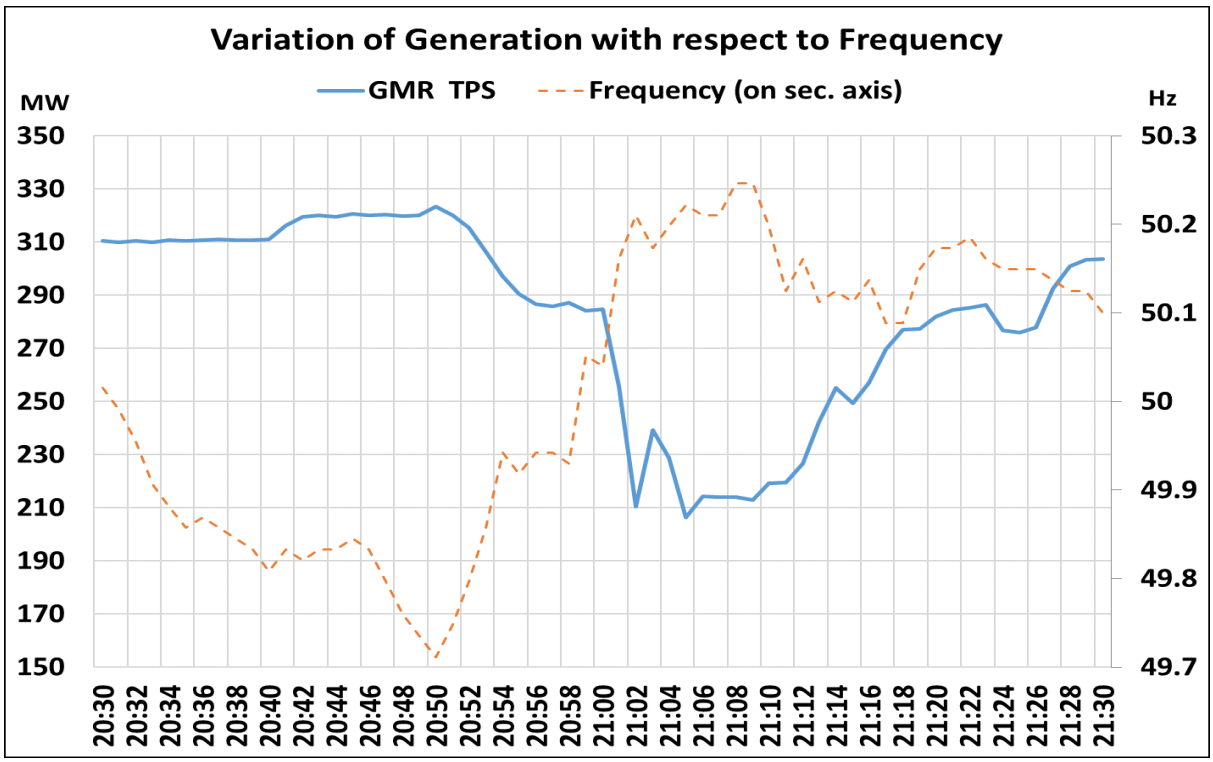
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
GMR TPS
Frequency (on sec. axis)
MW
Hz
350
330
310
290
270
250
230
210
190
170
150
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
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21:14
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21:22
21:24
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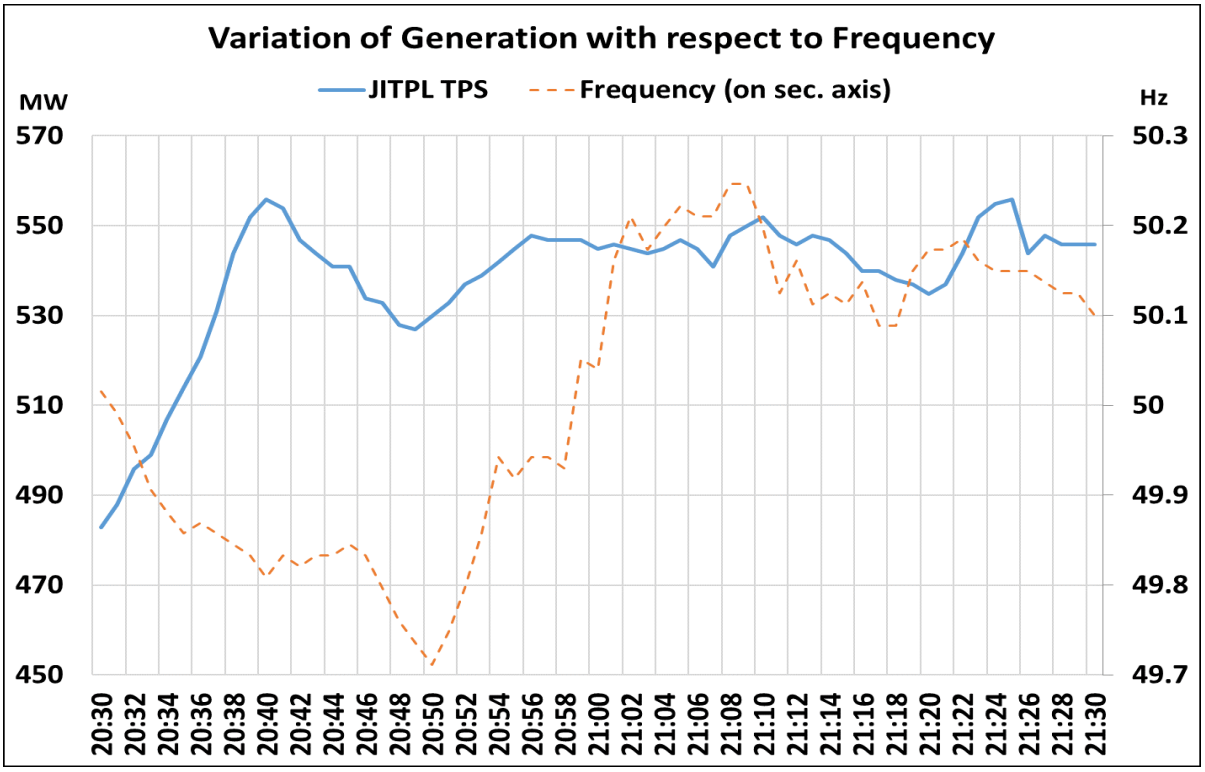
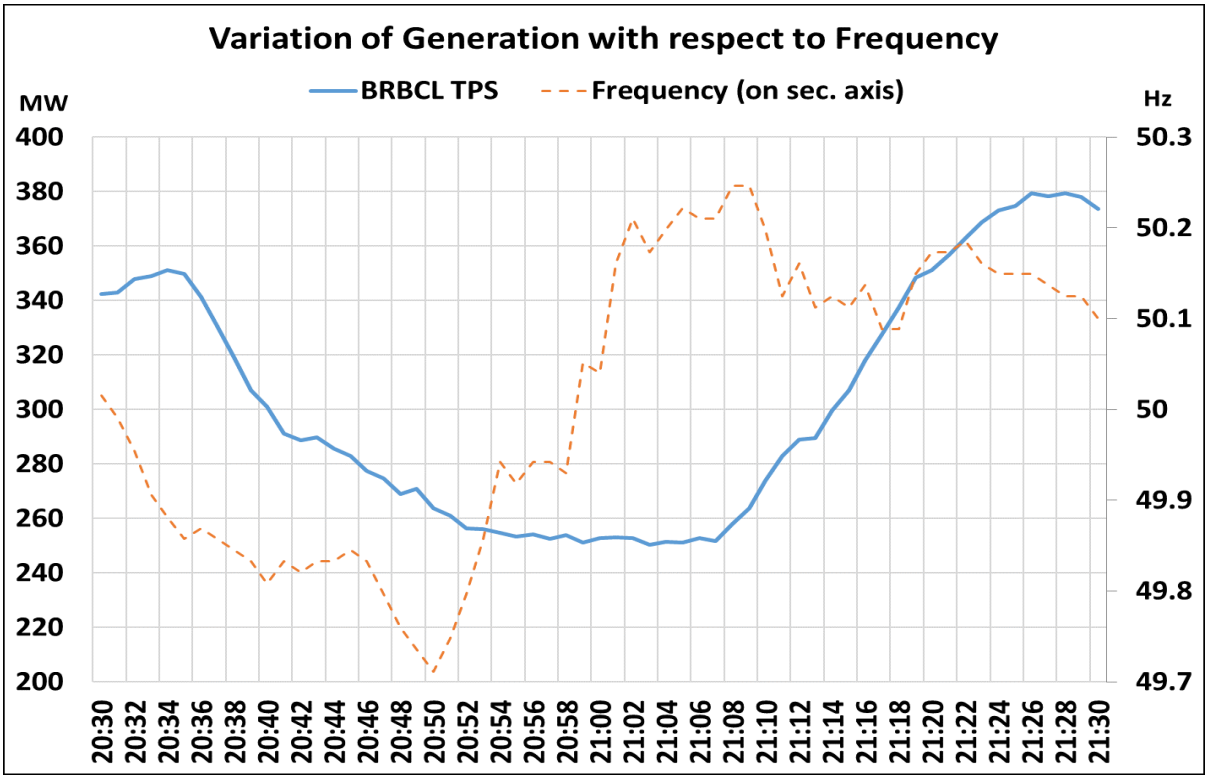
21:30


Variation of Generation with respect to Frequency
JITPL TPS
Frequency (on sec. axis)
MW
Hz
570
550
530
510
490
470
450
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
BRBCL TPS
Frequency (on sec. axis)
MW
Hz
400
380
360
340
320
300
280
260
240
220
200
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
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21:16
21:18
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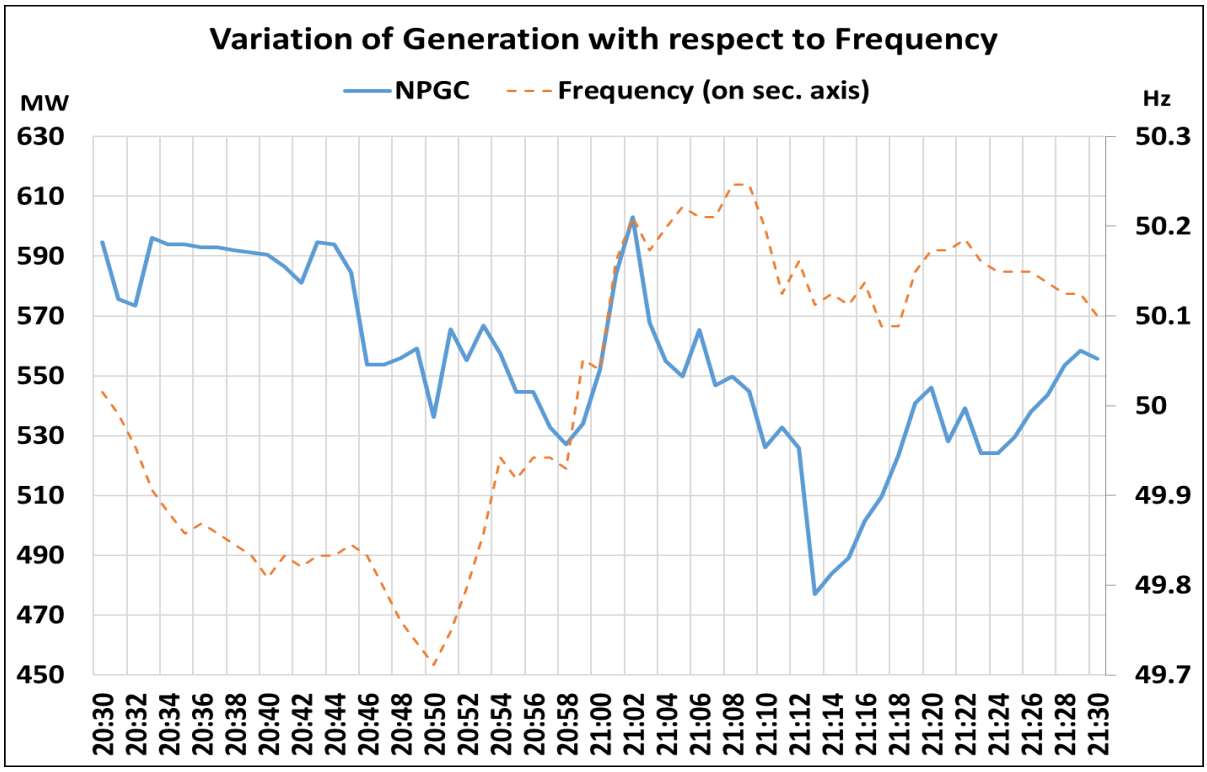
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
NPGC
Frequency (on sec. axis)
MW
Hz
630
610
590
570
550
530
510
490
470
450
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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21:12
21:14
21:16
21:18
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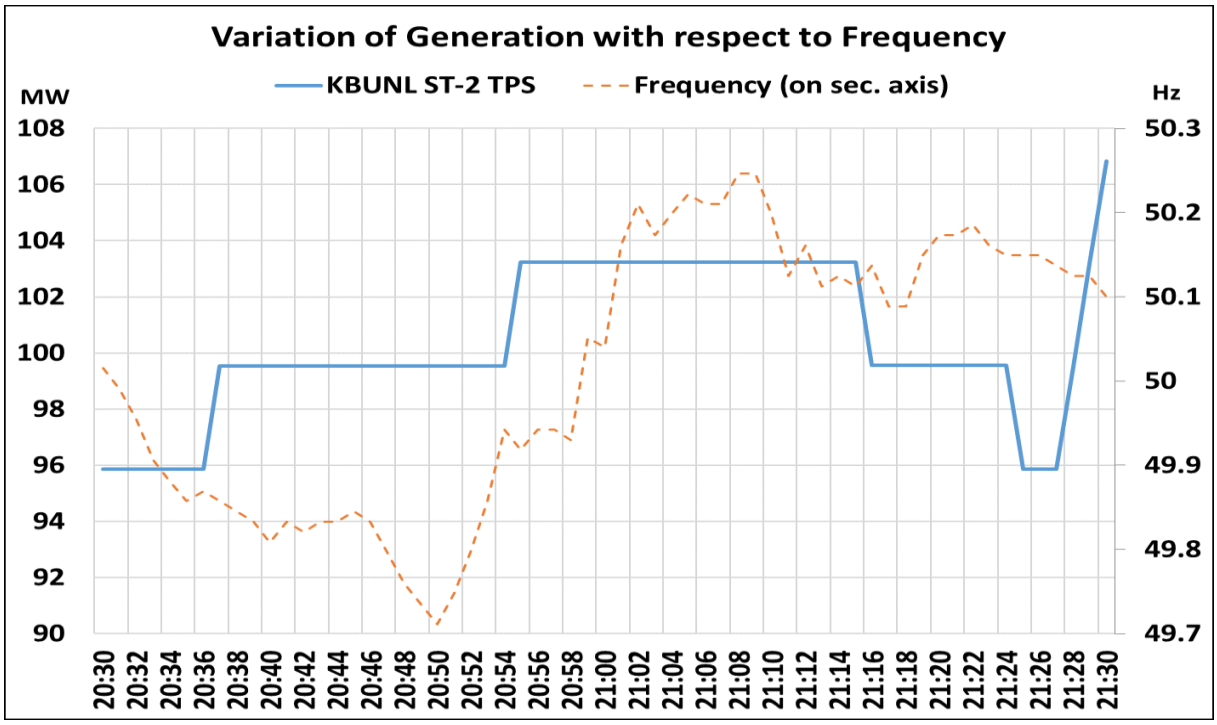
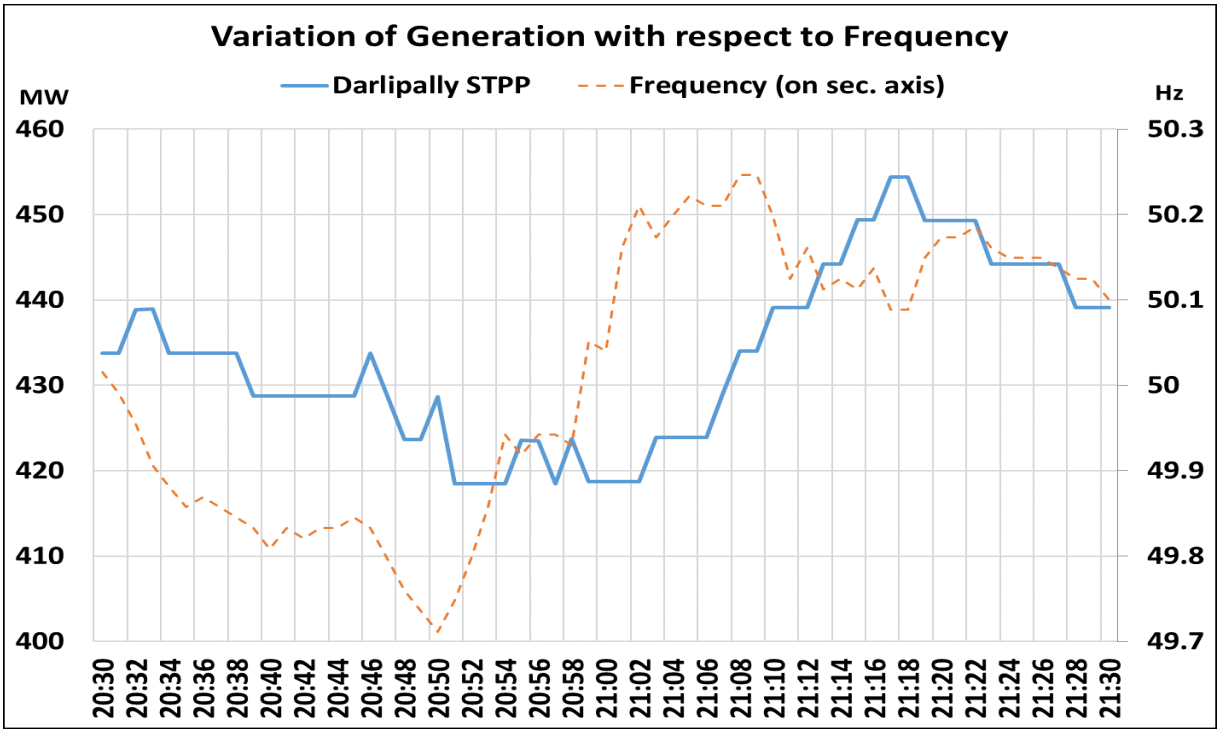
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
KBUNL ST-2 TPS
Frequency (on sec. axis)
MW
Hz
108
106
104
102
100
98
96
94
92
90
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Darlipally STPP
Frequency (on sec. axis)
MW
Hz
460
450
440
430
420
410
400
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
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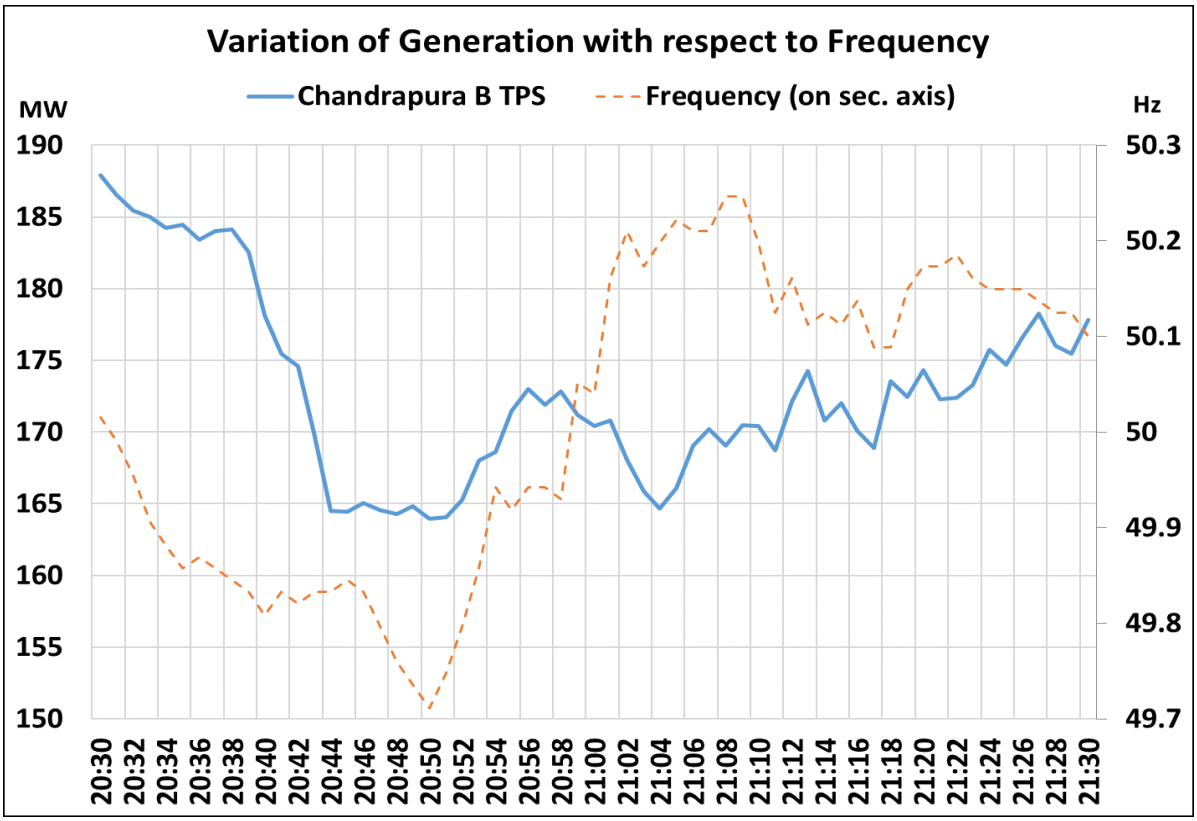
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Chandrapura B TPS
Frequency (on sec. axis)
MW
Hz
190
185
180
175
170
165
160
155
150
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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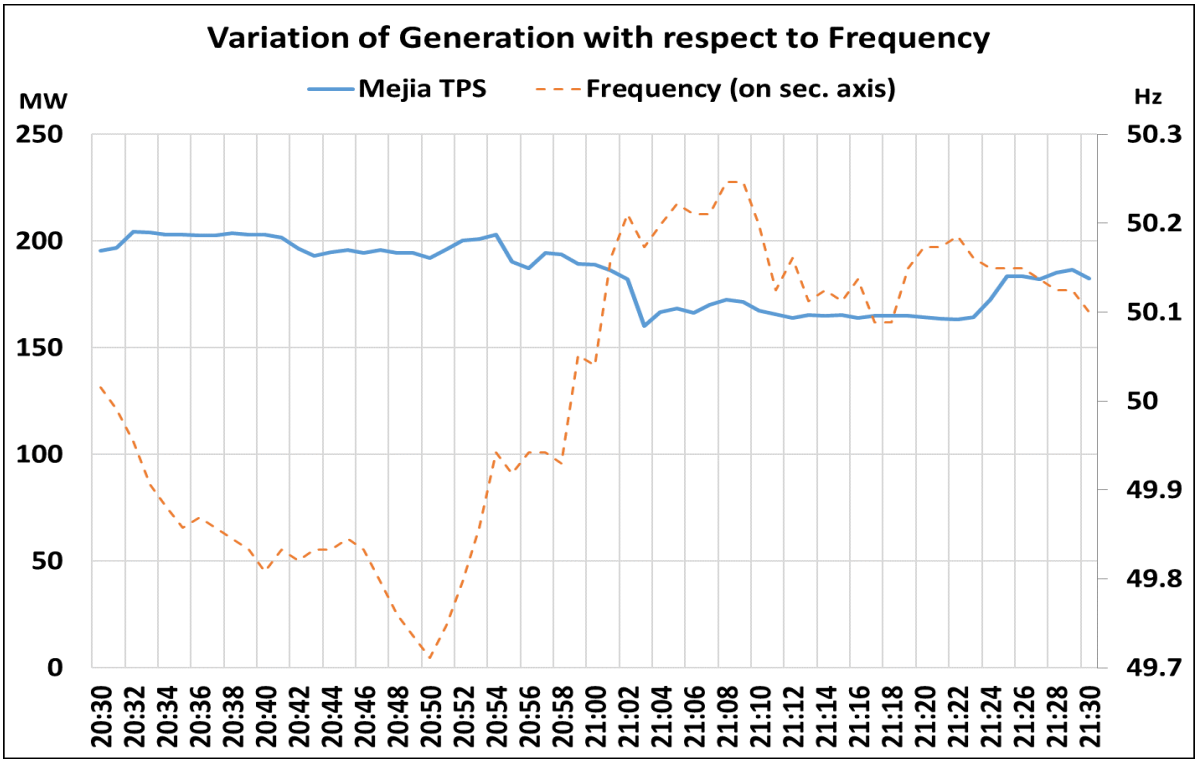
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Mejia TPS
Frequency (on sec. axis)
MW
Hz
250
200
150
100
50
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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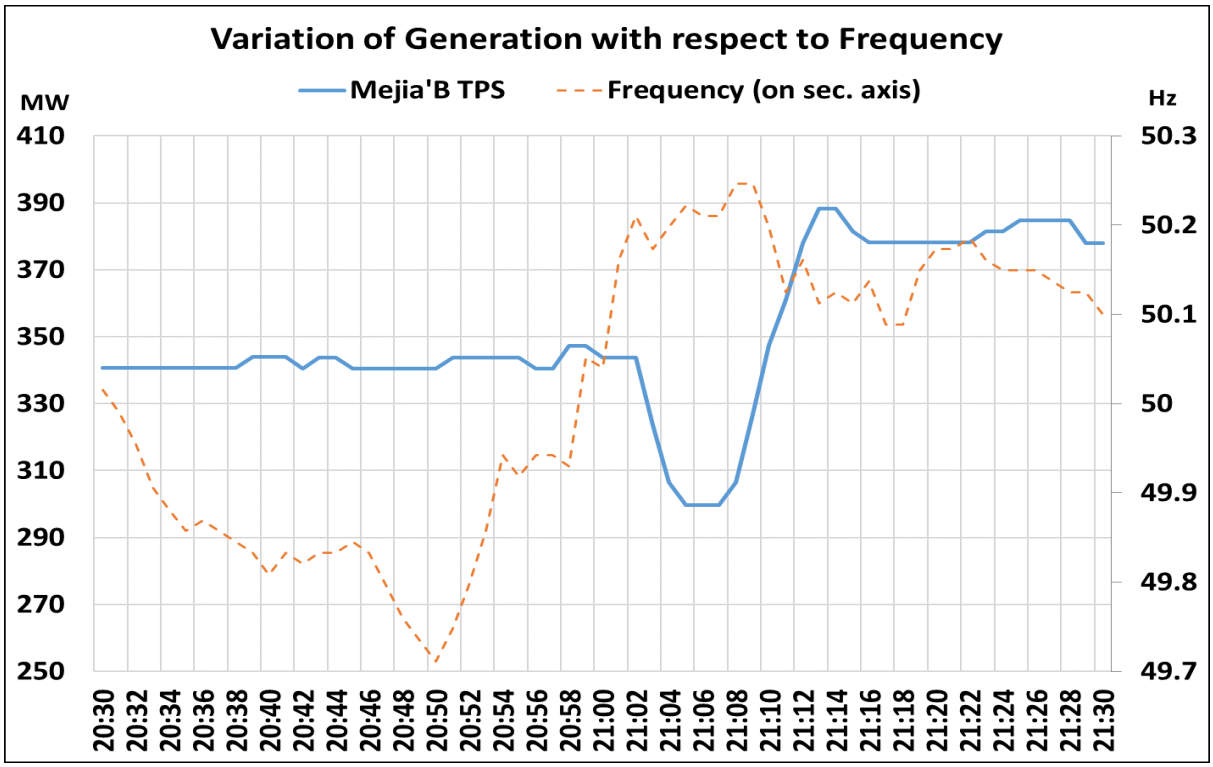
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Mejia'B TPS
Frequency (on sec. axis)
MW
Hz
410
390
370
350
330
310
290
270
250
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
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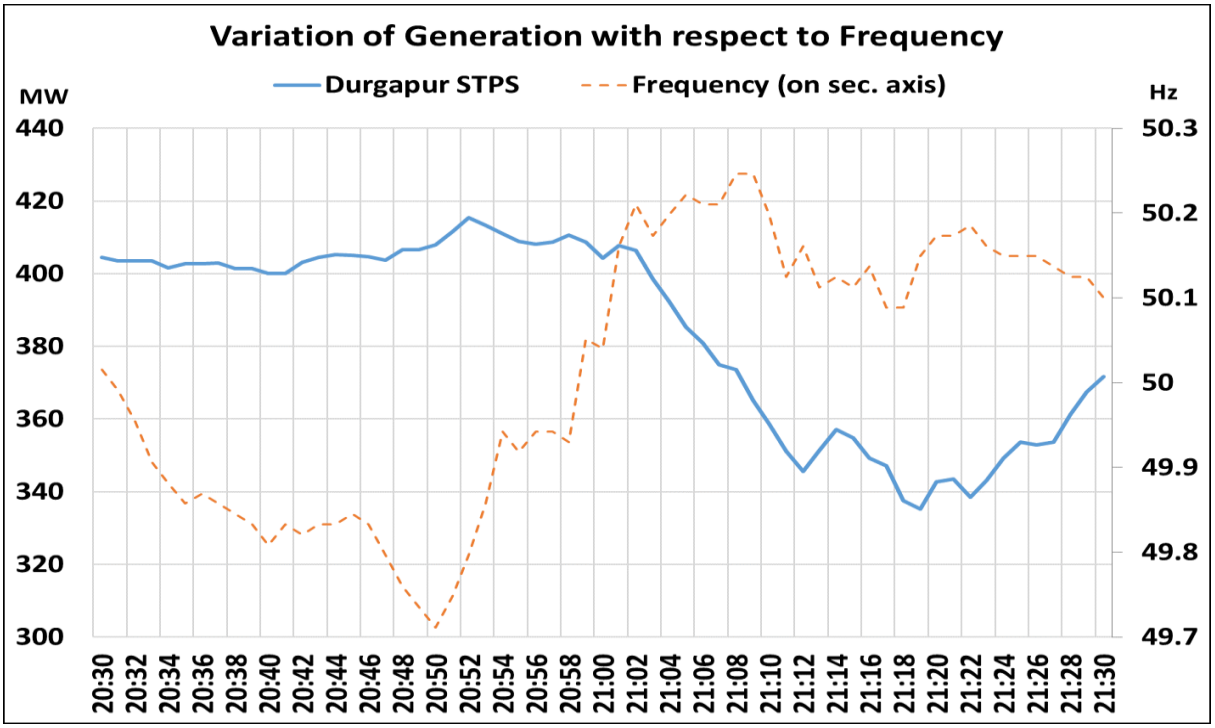
21:28
21:30


Variation of Generation with respect to Frequency
Durgapur STPS
Frequency (on sec. axis)
MW
Hz
440
420
400
380
360
340
320
300
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
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21:22
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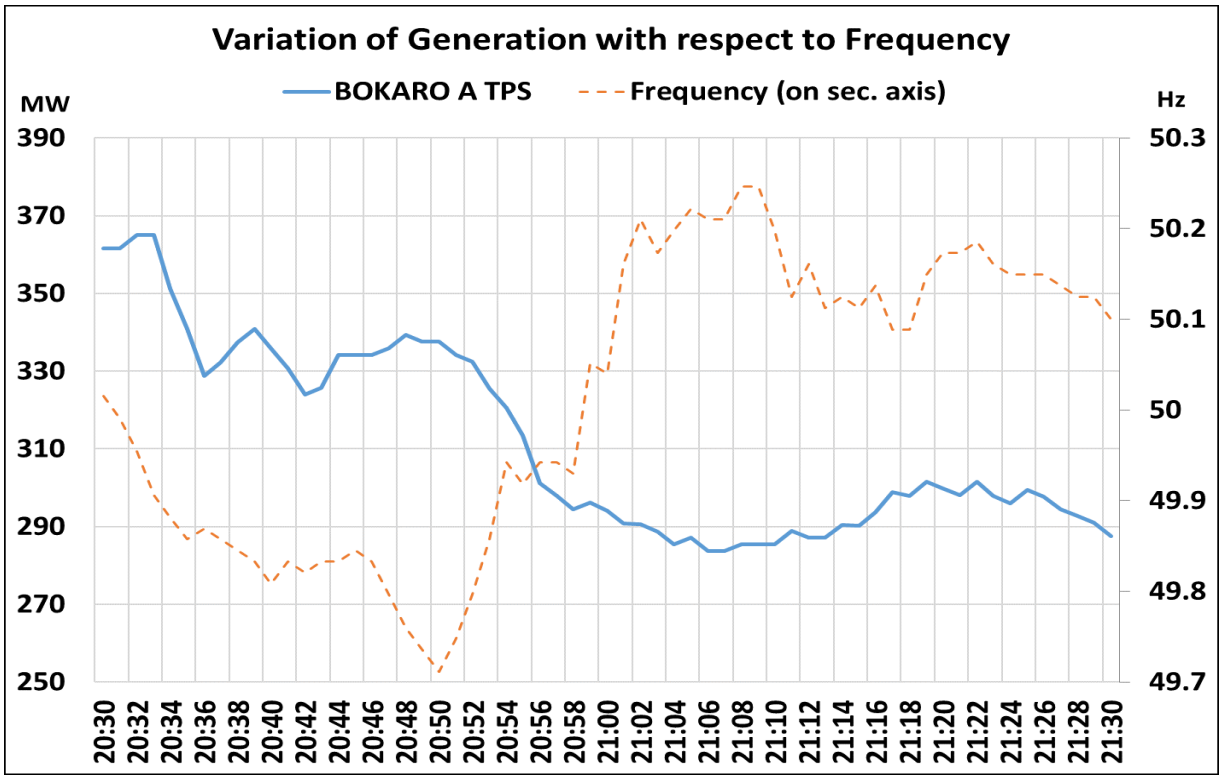
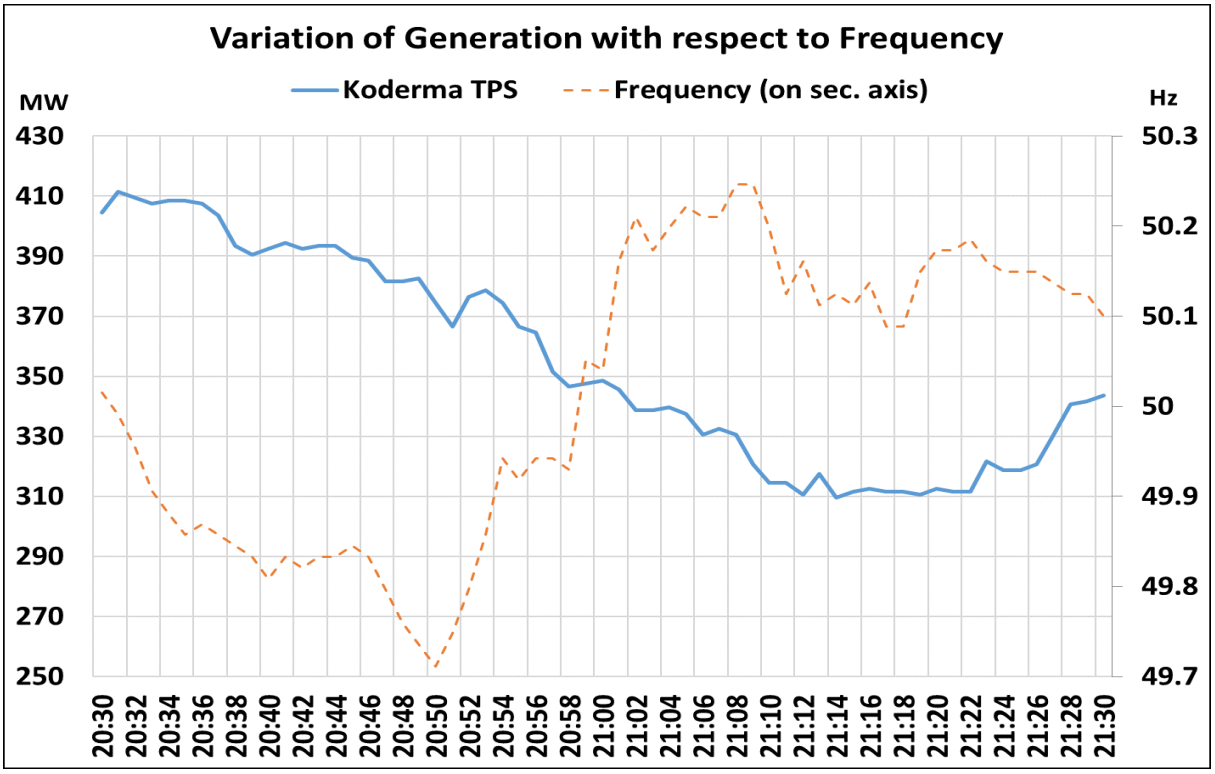
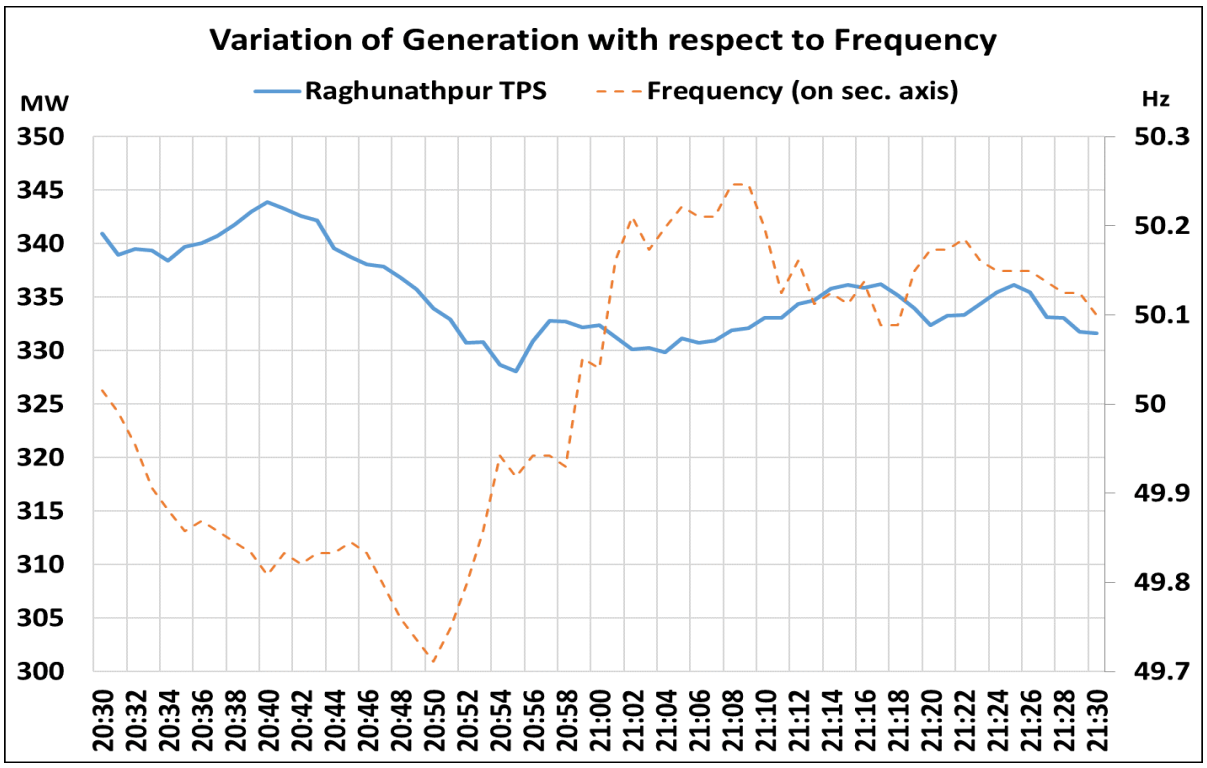
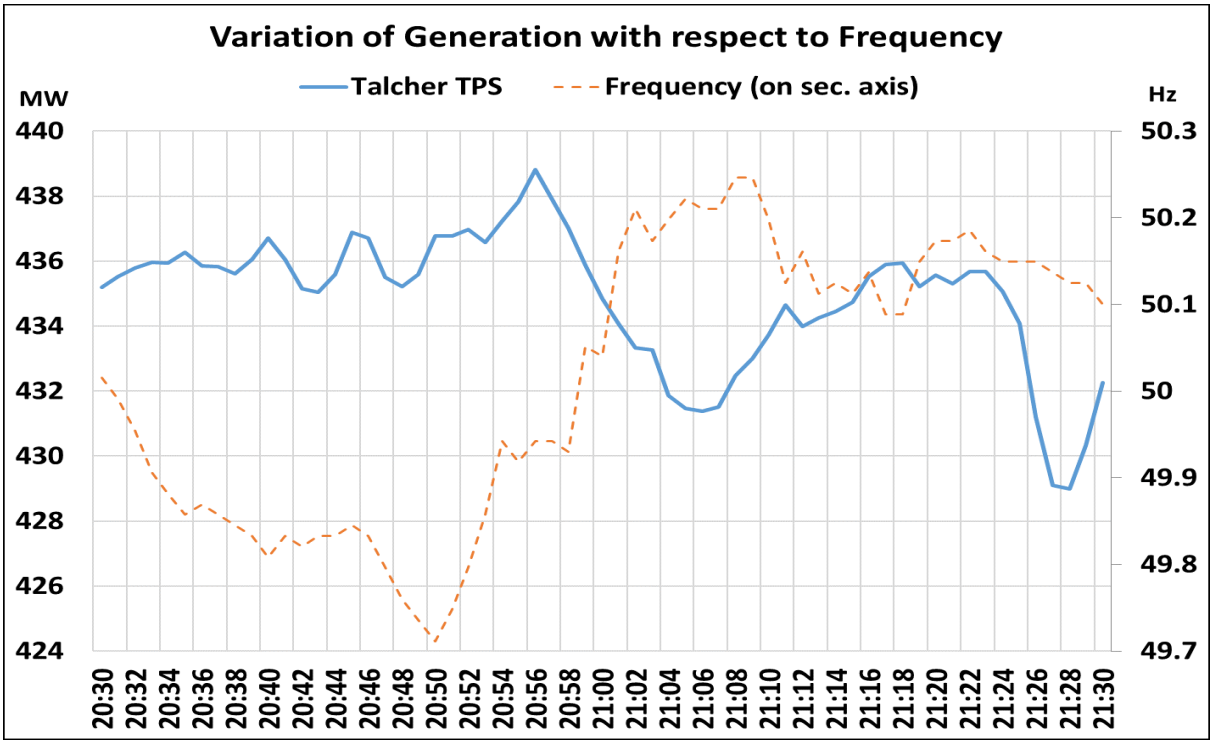
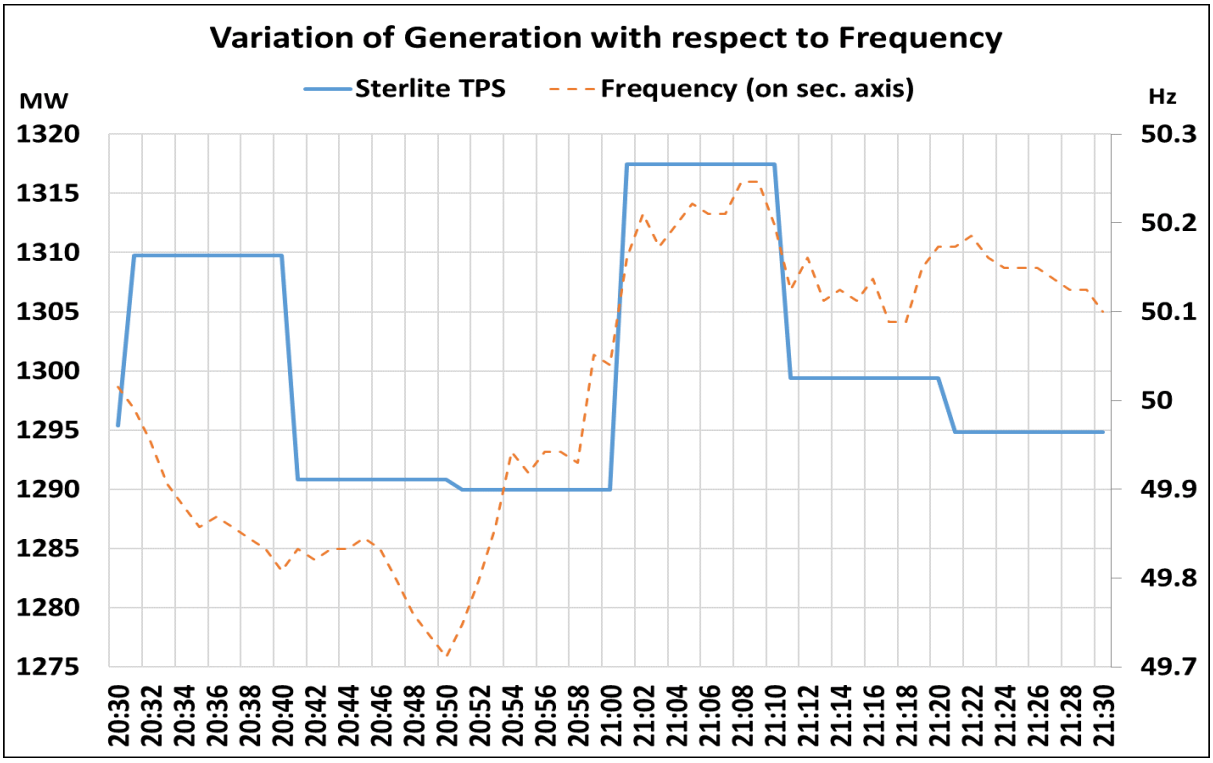
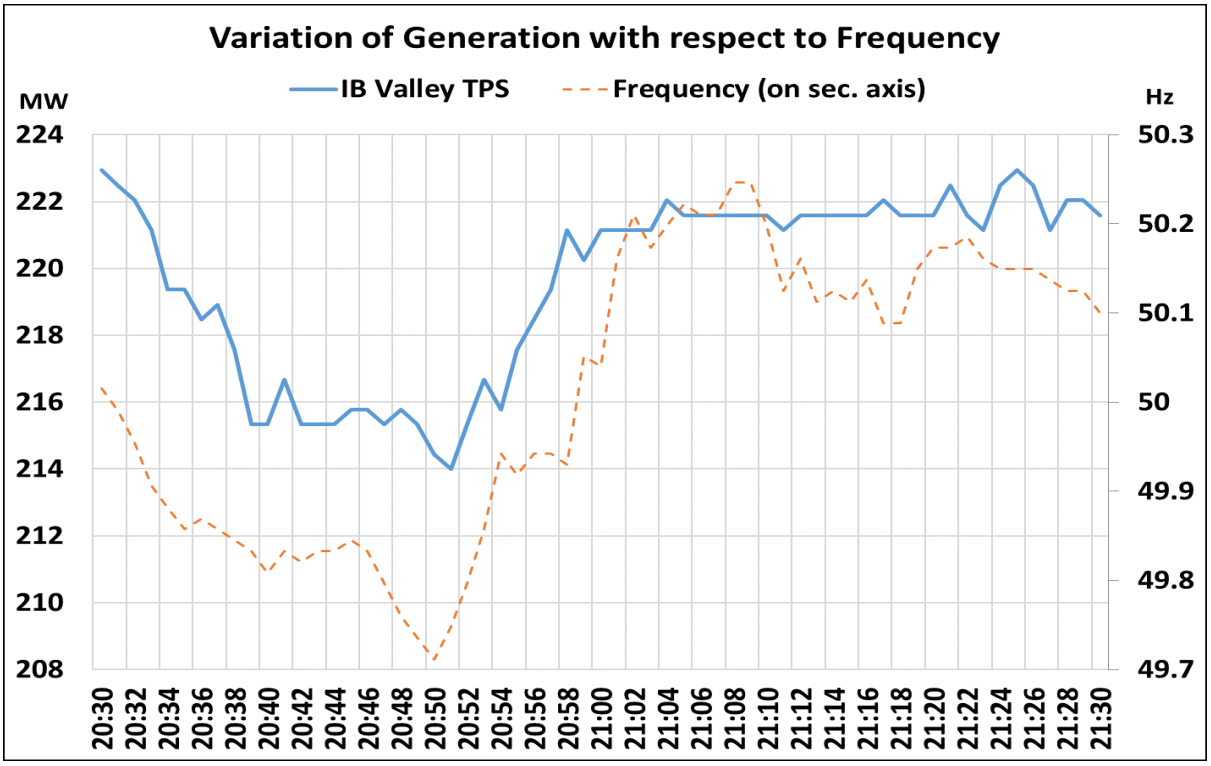

Variation of Generation with respect to Frequency
BOKARO A TPS
Frequency (on sec. axis)
MW
Hz
390
370
350
330
310
290
270
250
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Koderma TPS
Frequency (on sec. axis)
MW
Hz
430
410
390
370
350
330
310
290
270
250
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Raghunathpur TPS
Frequency (on sec. axis)
MW
Hz
350
345
340
335
330
325
320
315
310
305
300
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Talcher TPS
Frequency (on sec. axis)
MW
Hz
440
438
436
434
432
430
428
426
424
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Sterlite TPS
Frequency (on sec. axis)
MW
Hz
1320
1315
1310
1305
1300
1295
1290
1285
1280
1275
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
IB Valley TPS
Frequency (on sec. axis)
MW
Hz
224
222
220
218
216
214
212
210
208
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
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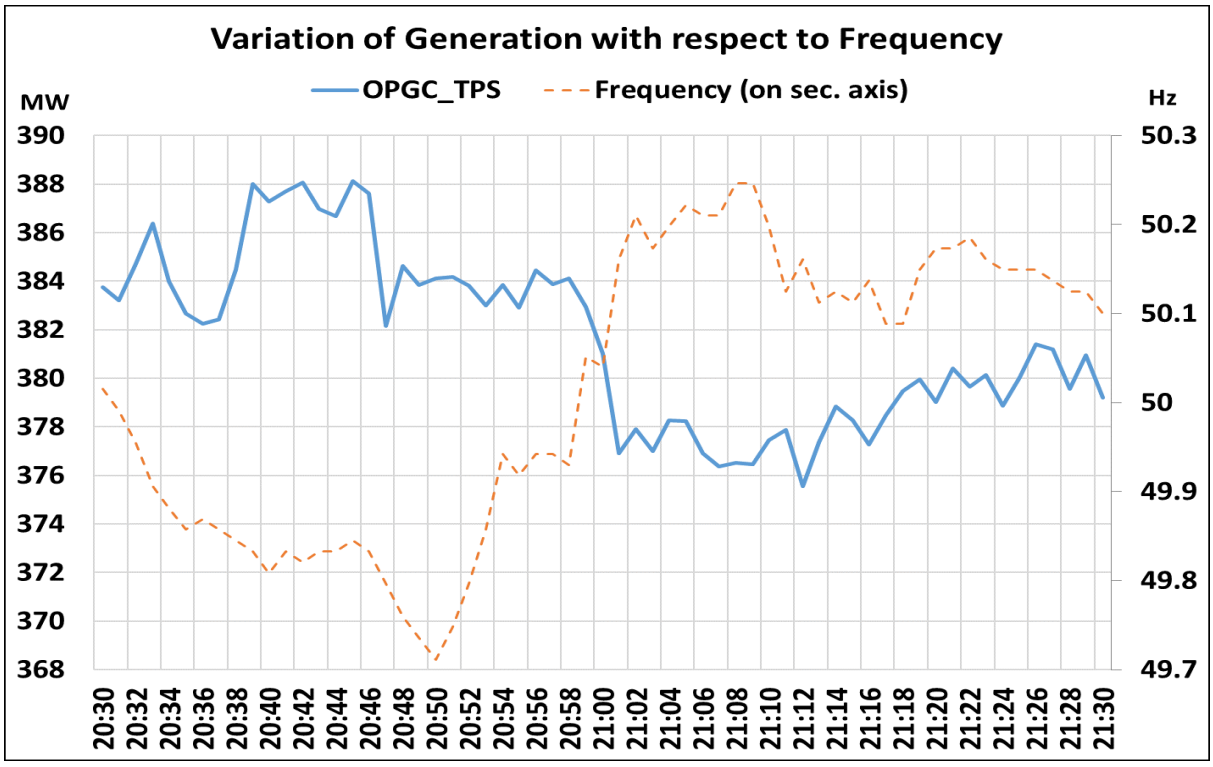
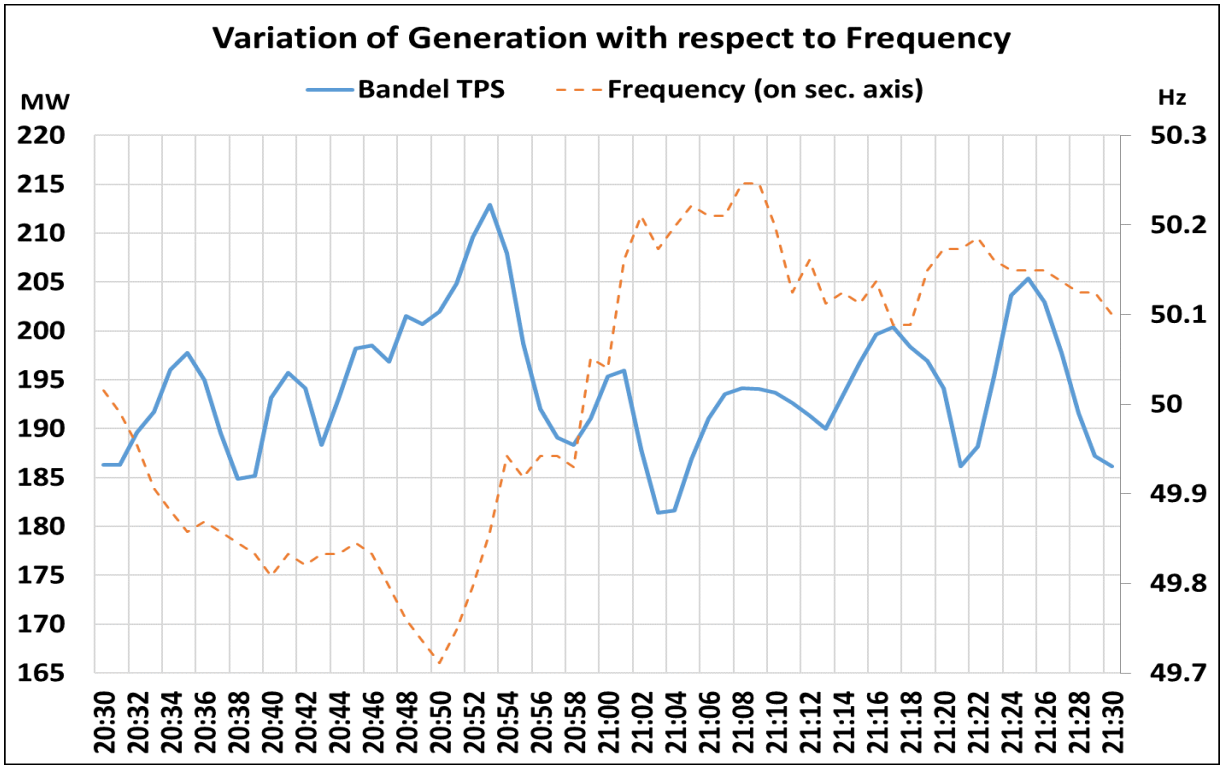
21:28
21:30


Variation of Generation with respect to Frequency
OPGC_TPS
Frequency (on sec. axis)
MW
Hz
390
388
386
384
382
380
378
376
374
372
370
368
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Bandel TPS
Frequency (on sec. axis)
MW
Hz
220
215
210
205
200
195
190
185
180
175
170
165
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
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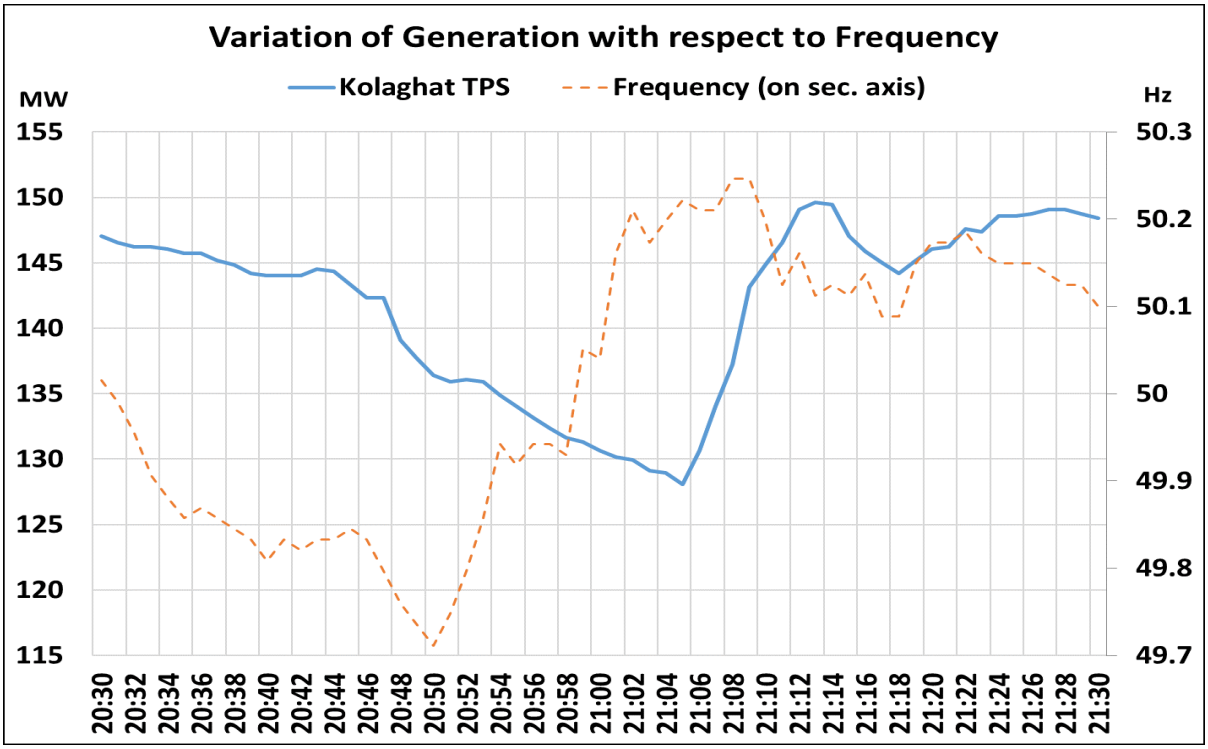
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Kolaghat TPS
Frequency (on sec. axis)
MW
Hz
155
150
145
140
135
130
125
120
115
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
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21:14
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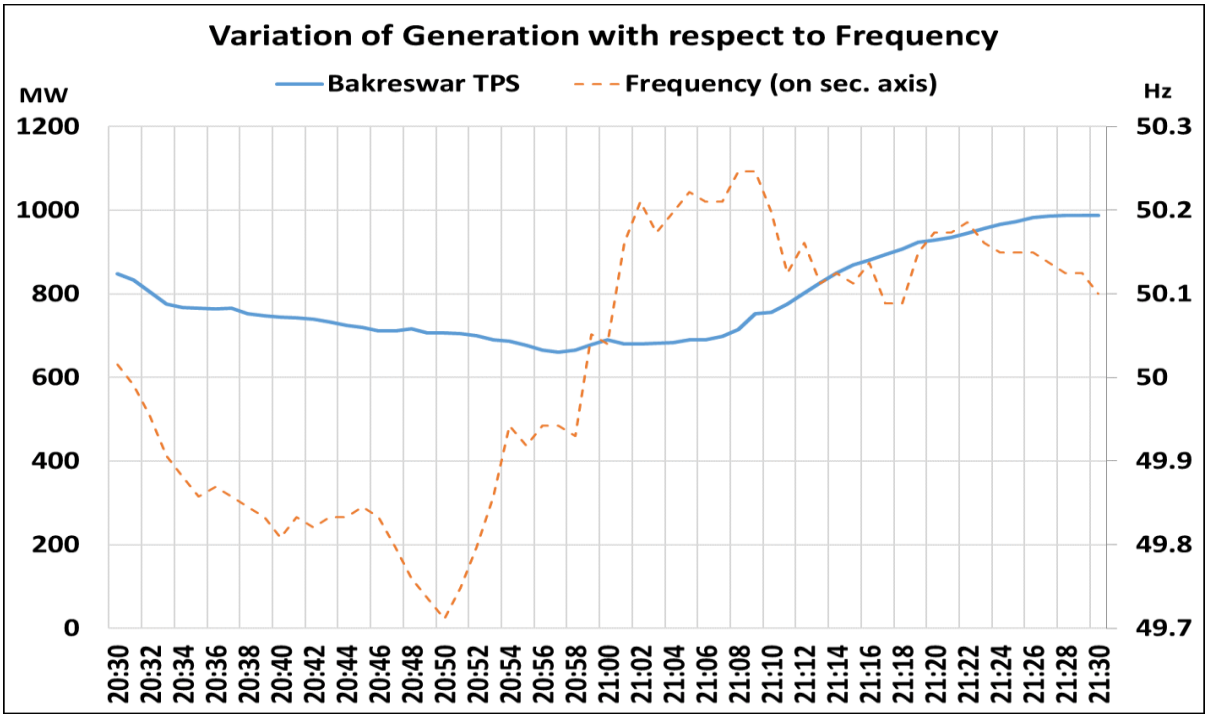
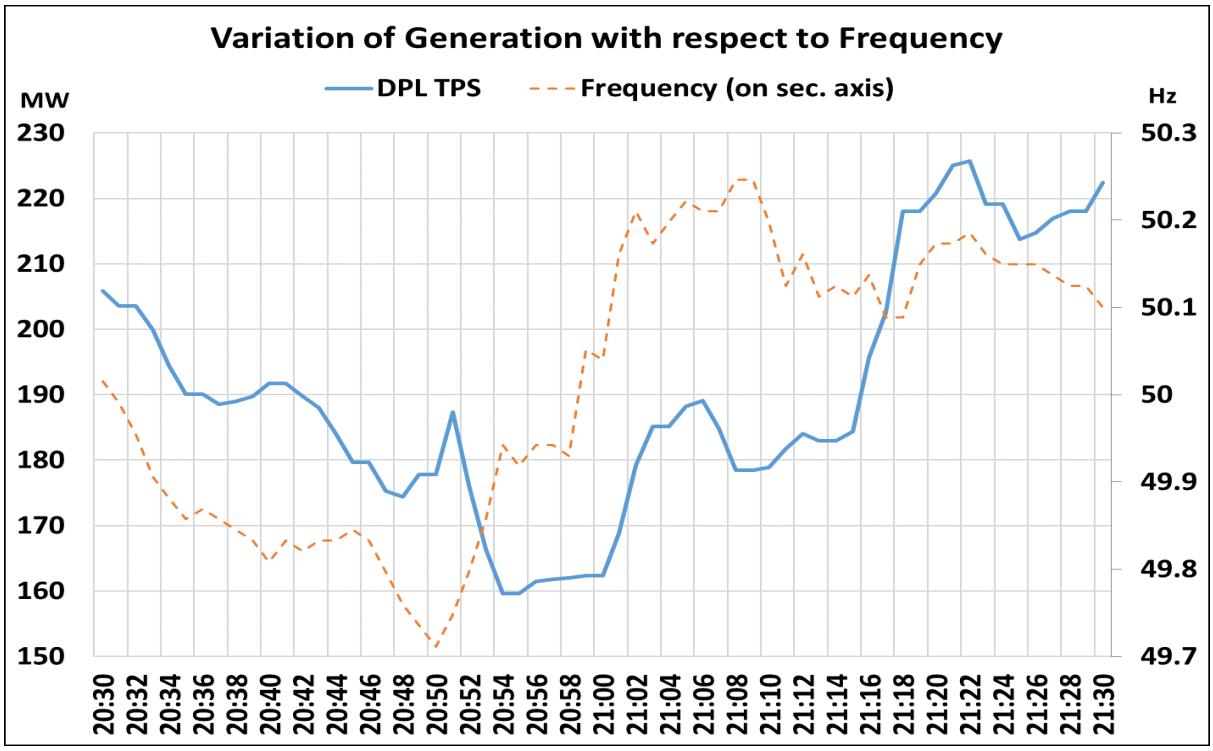
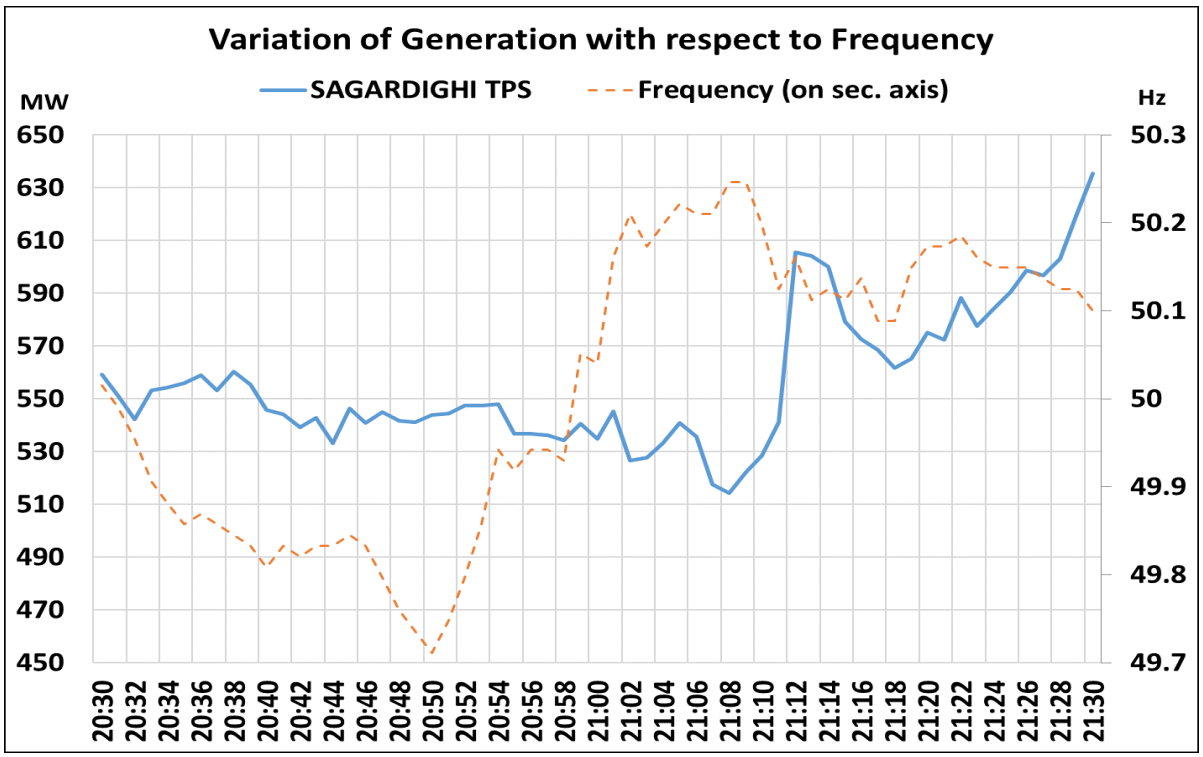
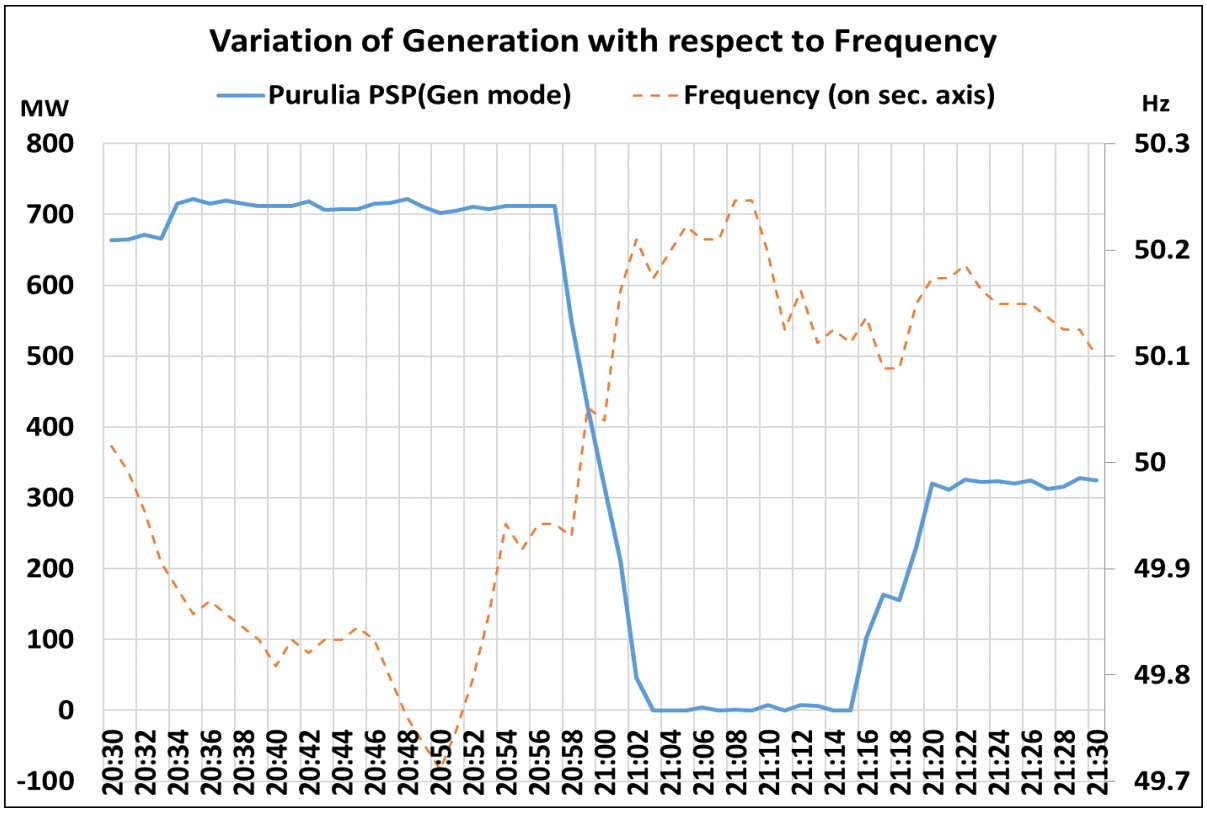
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Bakreswar TPS
Frequency (on sec. axis)
MW
Hz
1200
1000
800
600
400
200
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
DPL TPS
Frequency (on sec. axis)
MW
Hz
230
220
210
200
190
180
170
160
150
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
SAGARDIGHI TPS
Frequency (on sec. axis)
MW
Hz
650
630
610
590
570
550
530
510
490
470
450
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Purulia PSP(Gen mode)
Frequency (on sec. axis)
MW
Hz
800
700
600
500
400
300
200
100
0
-100
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
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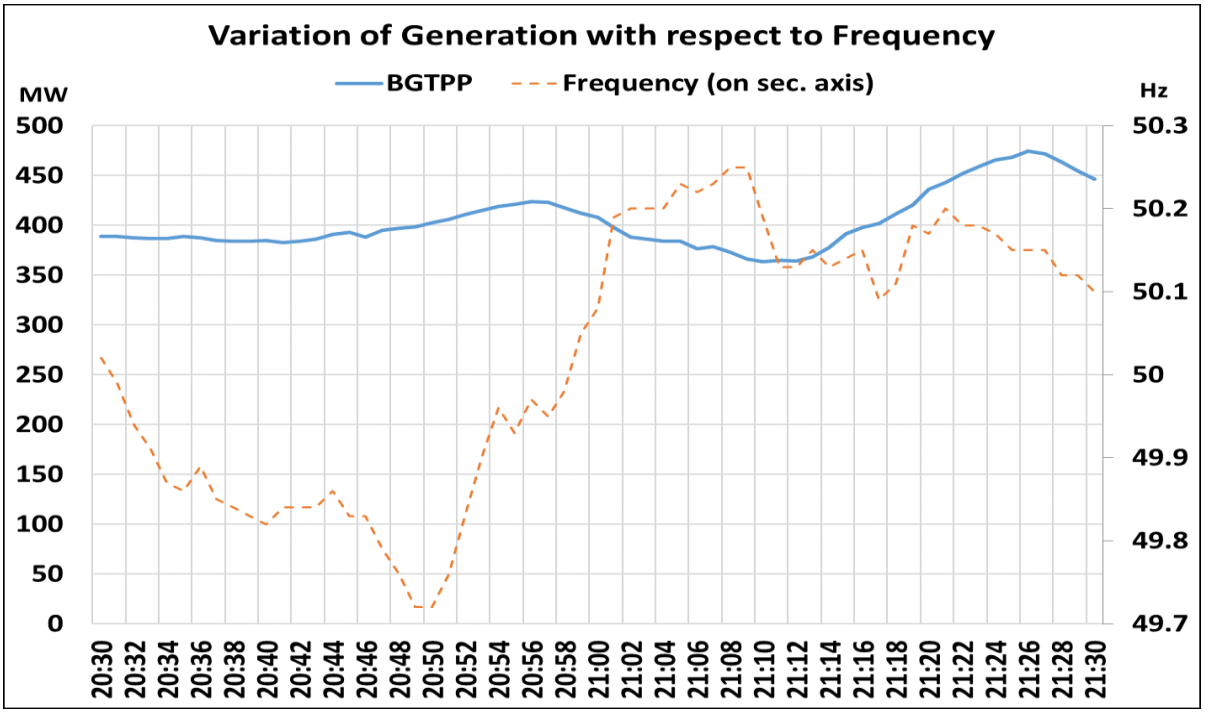
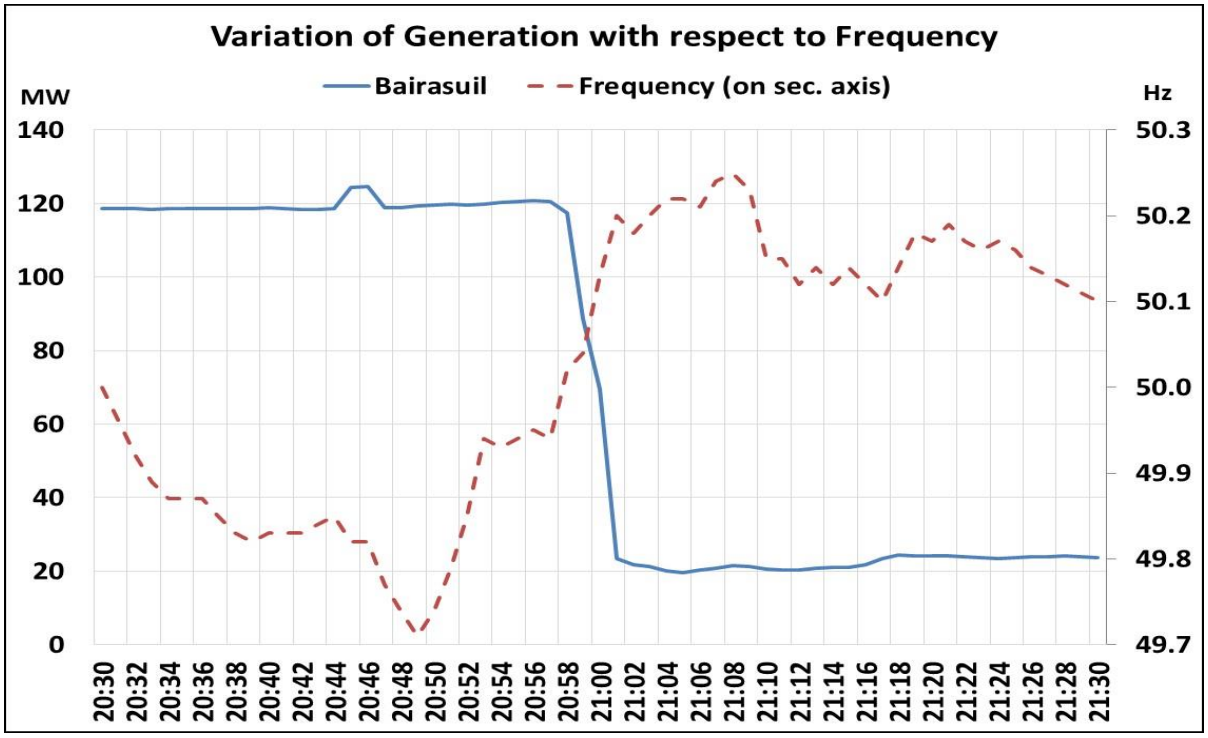
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

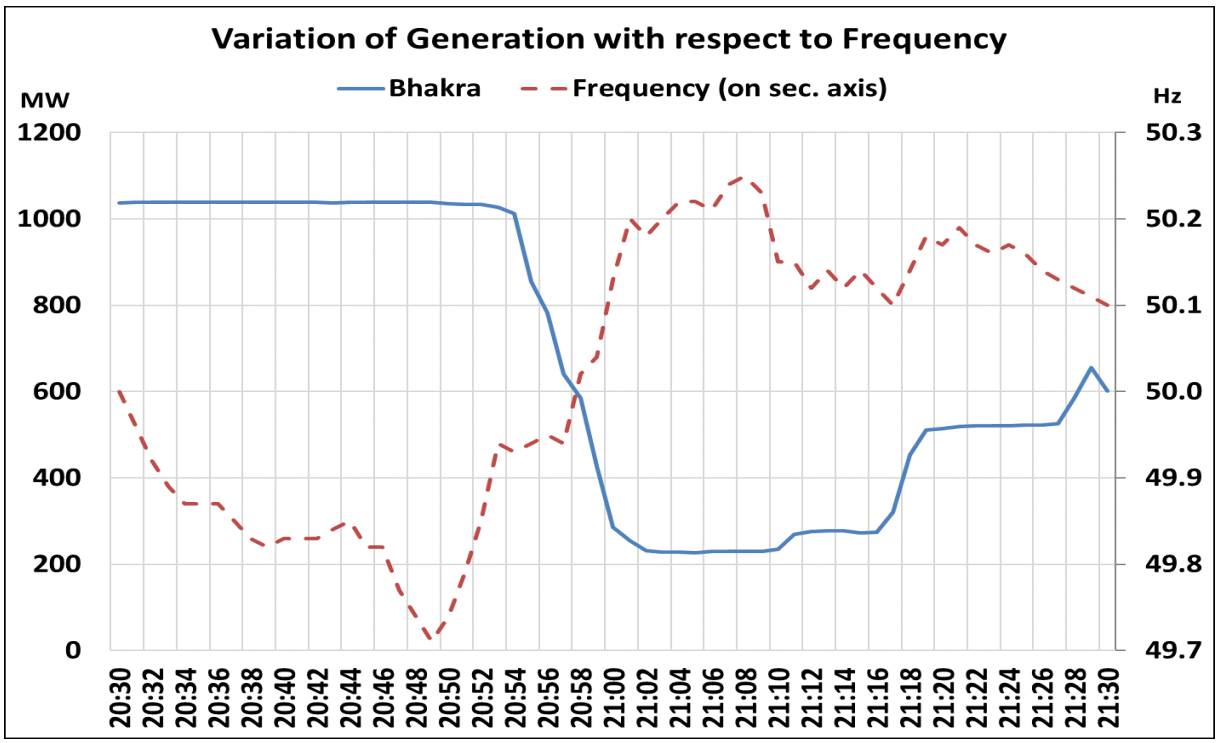
North Eastern Region

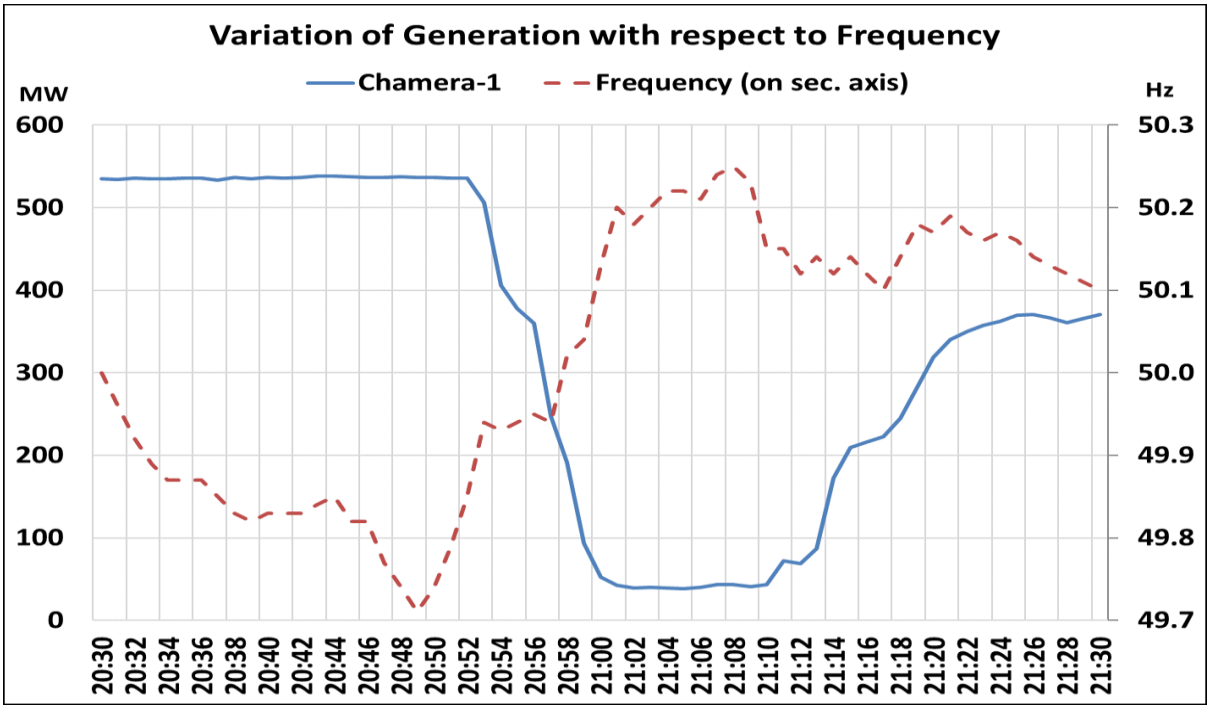


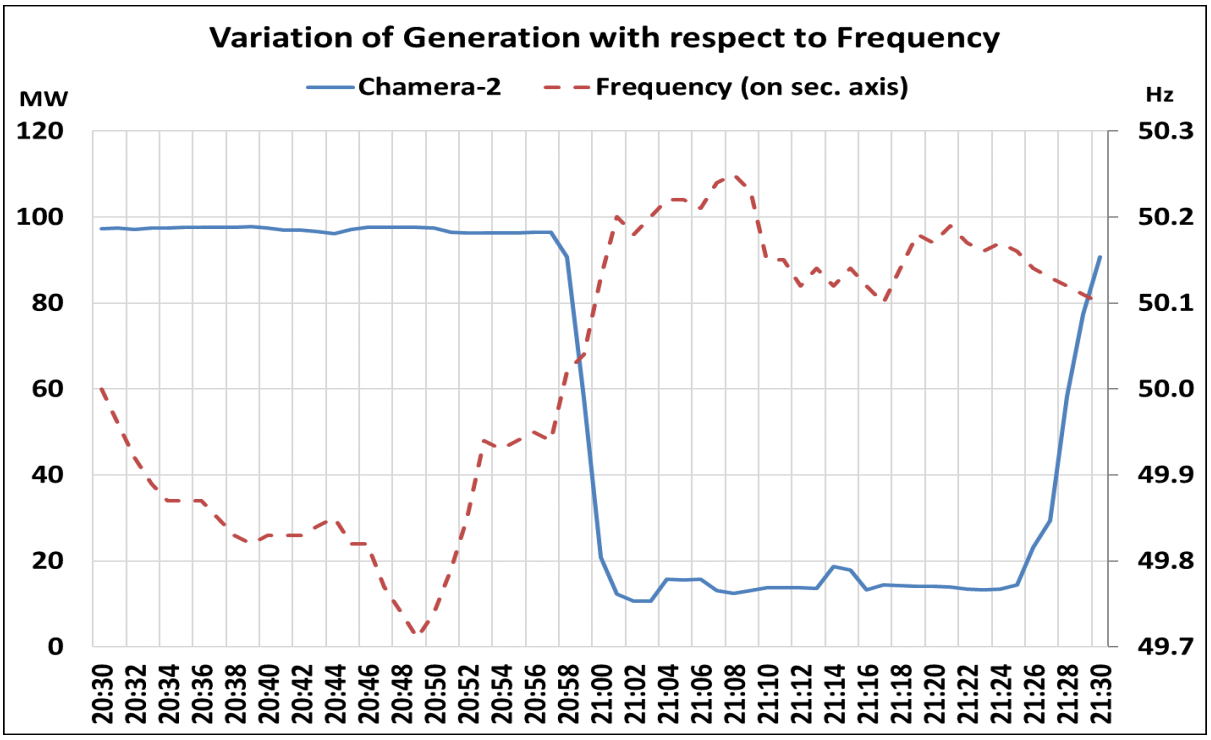
Annexure 7.3 Plant Wise Hydro Generation

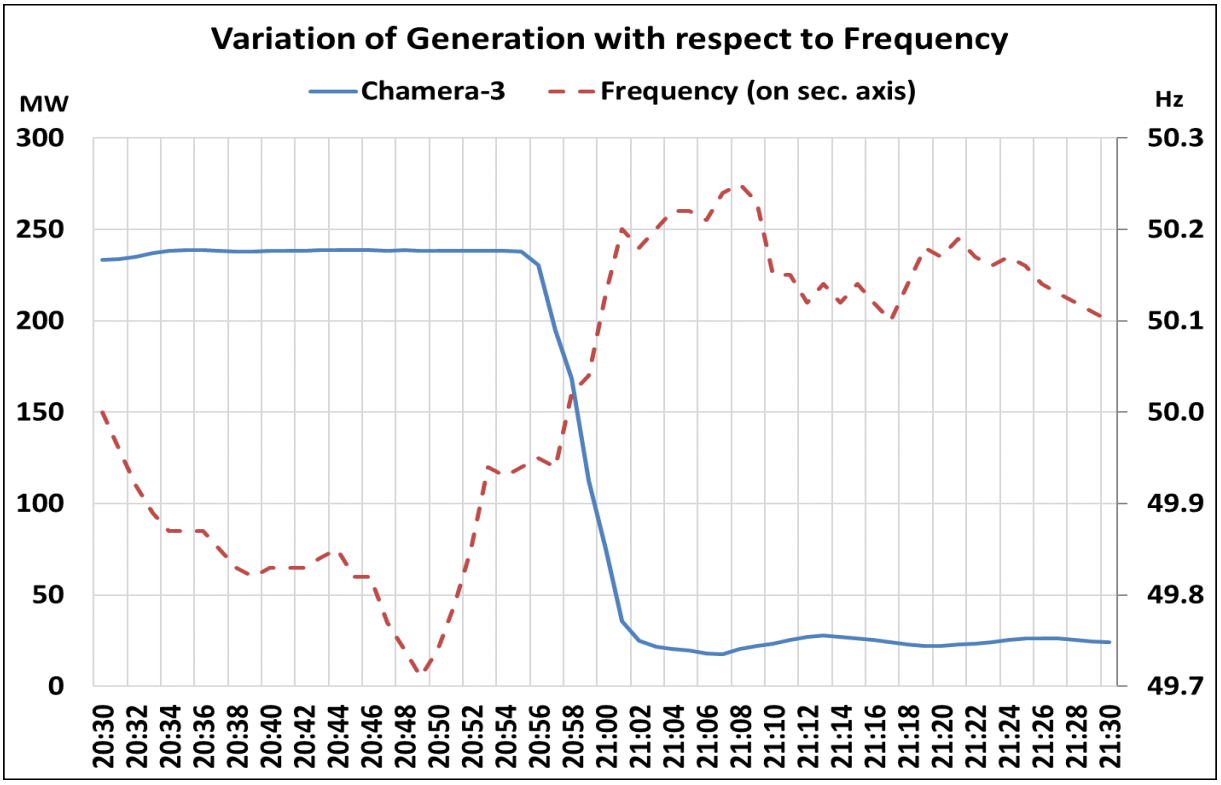
Northern region

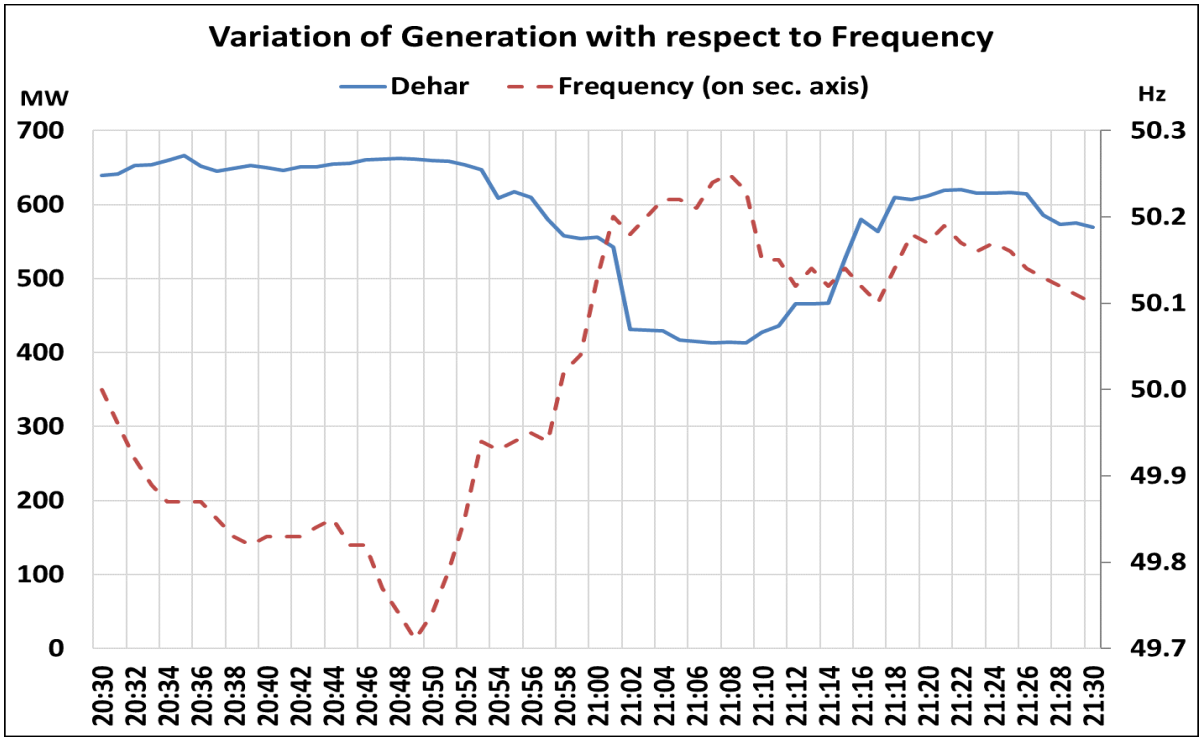





Variation of Generation with respect to Frequency
Chamera-1
Frequency (on sec. axis)
MW
Hz
600
500
400
300
200
100
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Chamera-2
Frequency (on sec. axis)
MW
Hz
120
100
80
60
40
20
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Chamera-3
Frequency (on sec. axis)
MW
Hz
300
250
200
150
100
50
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Dehar
Frequency (on sec. axis)
MW
Hz
700
600
500
400
300
200
100
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
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21:18
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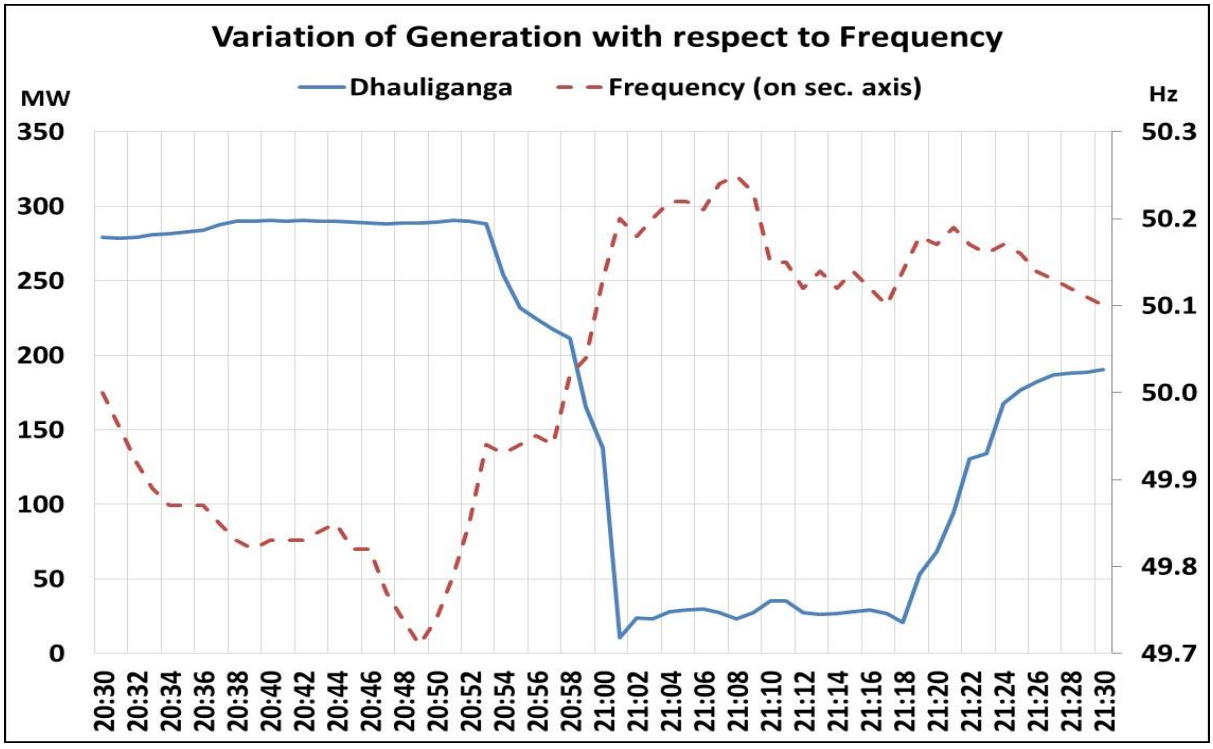
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Dhauliganga
Frequency (on sec. axis)
MW
Hz
350
300
250
200
150
100
50
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
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20:42
20:44
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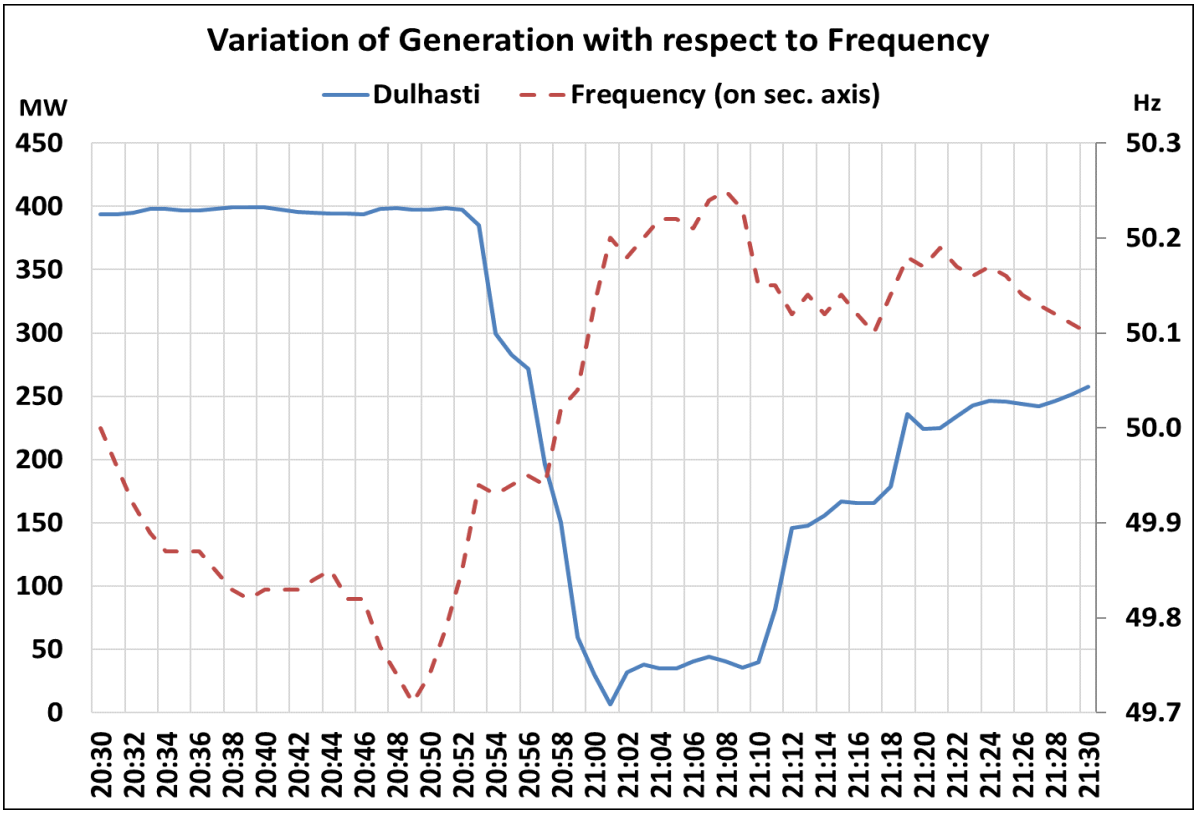
Variation of Generation with respect to Frequency
Dulhasti
Frequency (on sec. axis)
MW
Hz
450
400
350
300
250
200
150
100
50
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
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20:38
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20:46
20:48
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20:54
20:56
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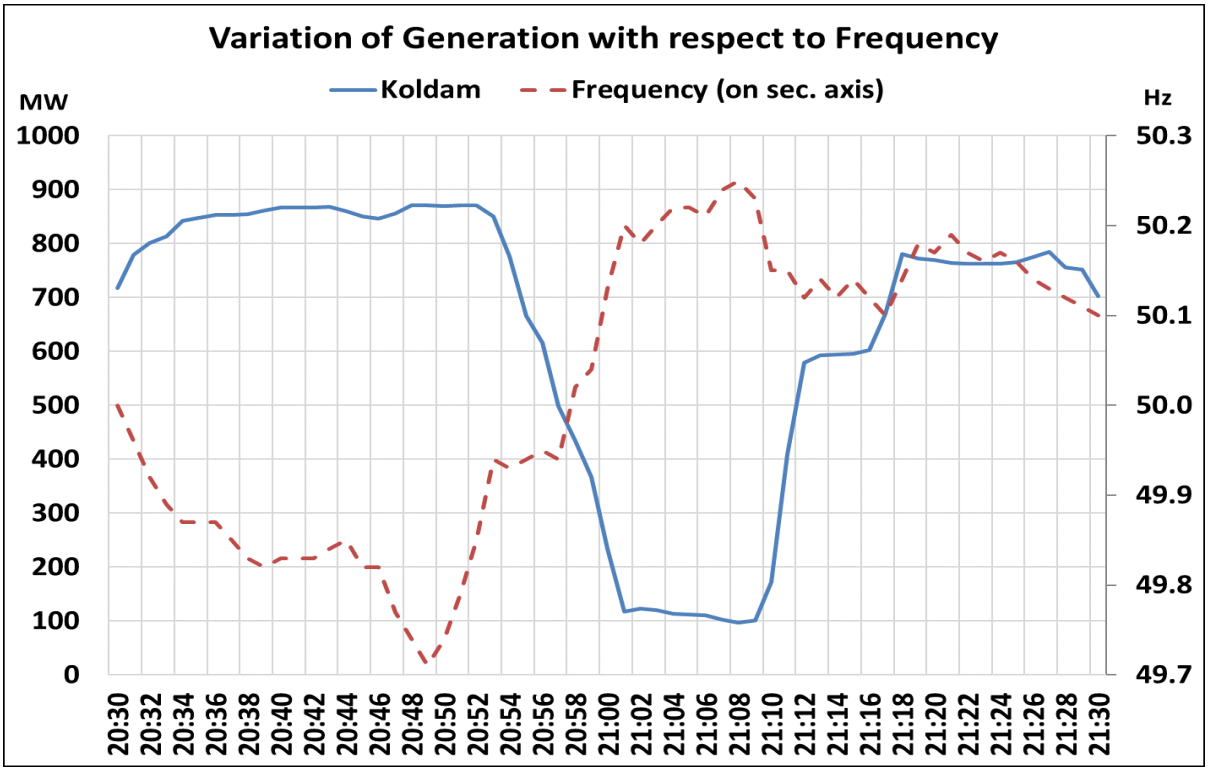
Variation of Generation with respect to Frequency
Koldam
Frequency (on sec. axis)
MW
Hz
1000
900
800
700
600
500
400
300
200
100
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
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20:50
20:52
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21:28
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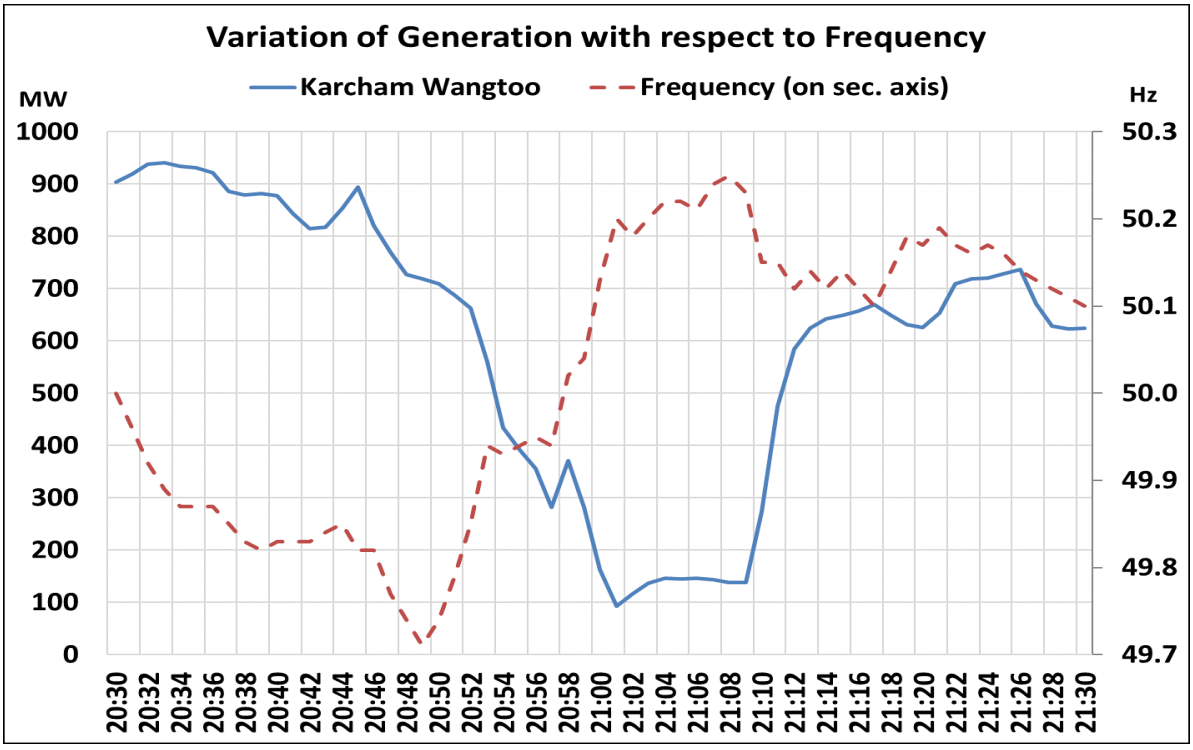
Variation of Generation with respect to Frequency
Karcham Wangtoo
Frequency (on sec. axis)
MW
Hz
1000
900
800
700
600
500
400
300
200
100
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
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20:50
20:52
20:54
20:56
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21:28
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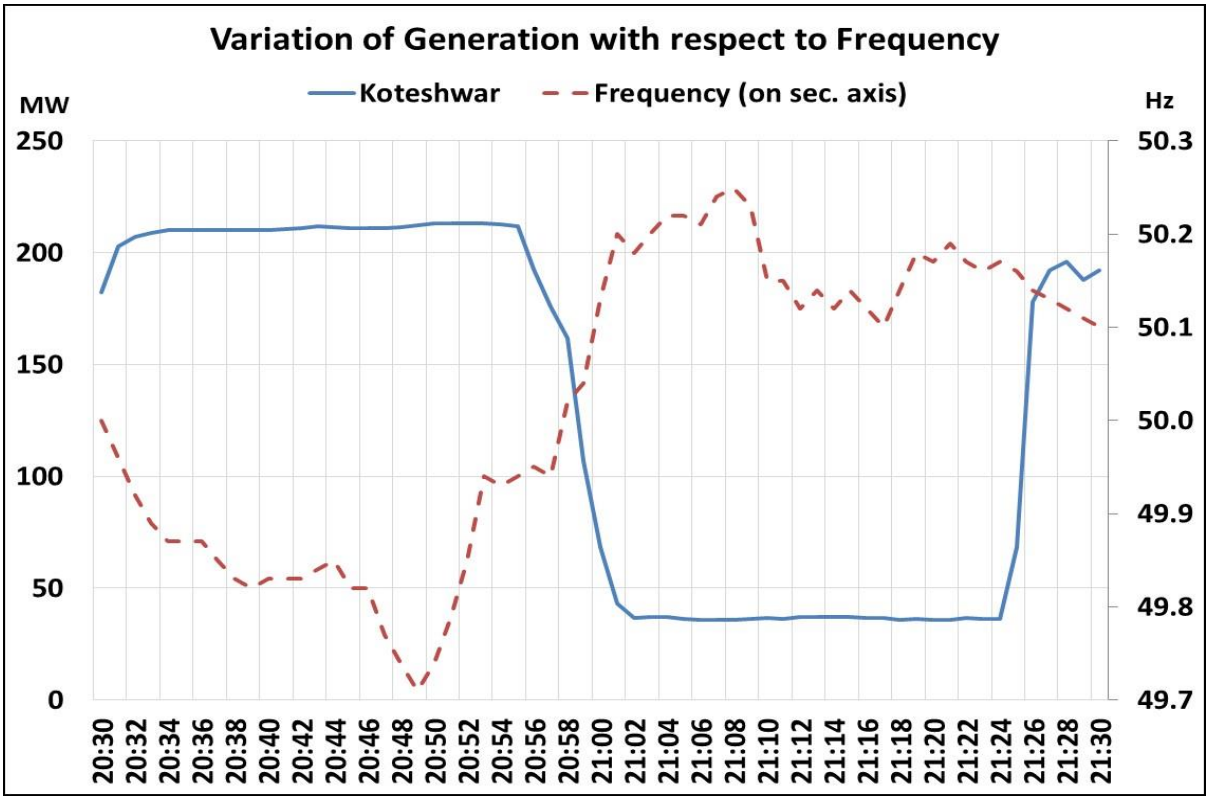
Variation of Generation with respect to Frequency
Koteshwar
Frequency (on sec. axis)
MW
Hz
250
200
150
100
50
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
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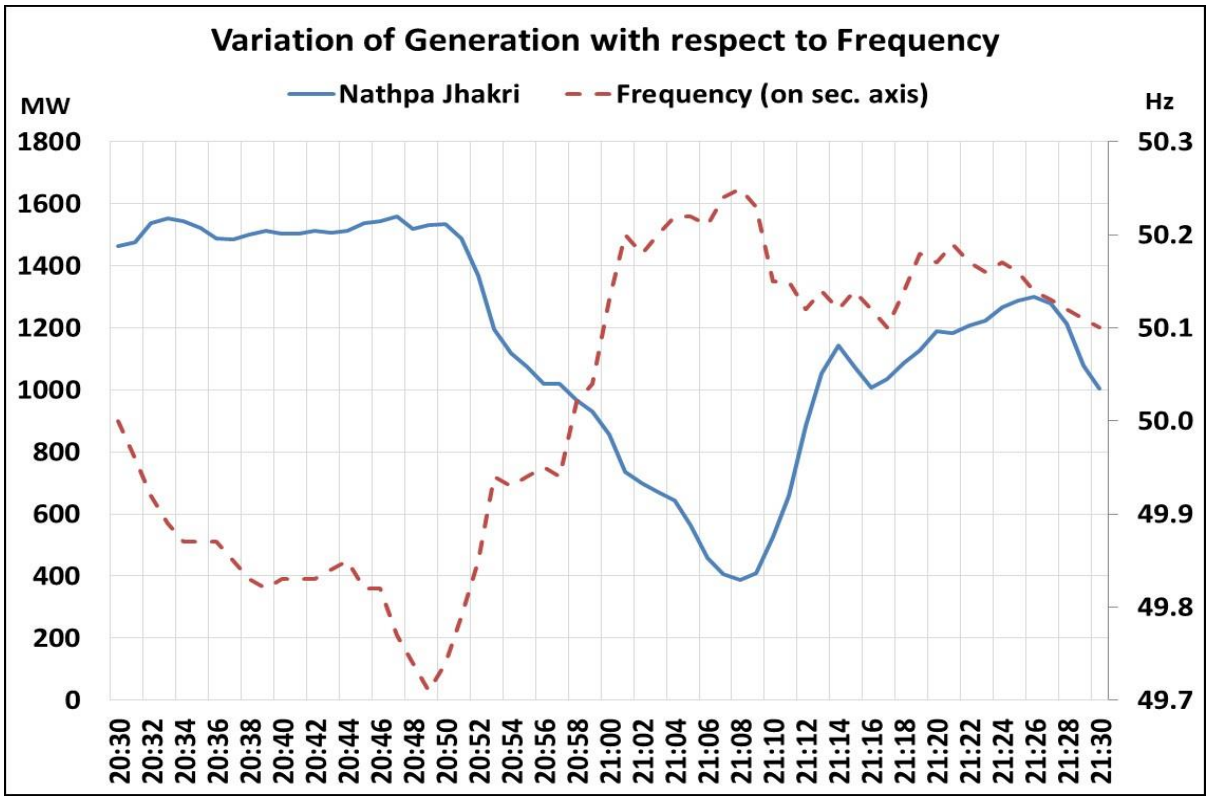
Variation of Generation with respect to Frequency
Nathpa Jhakri
Frequency (on sec. axis)
MW
Hz
1800
1600
1400
1200
1000
800
600
400
200
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
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20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
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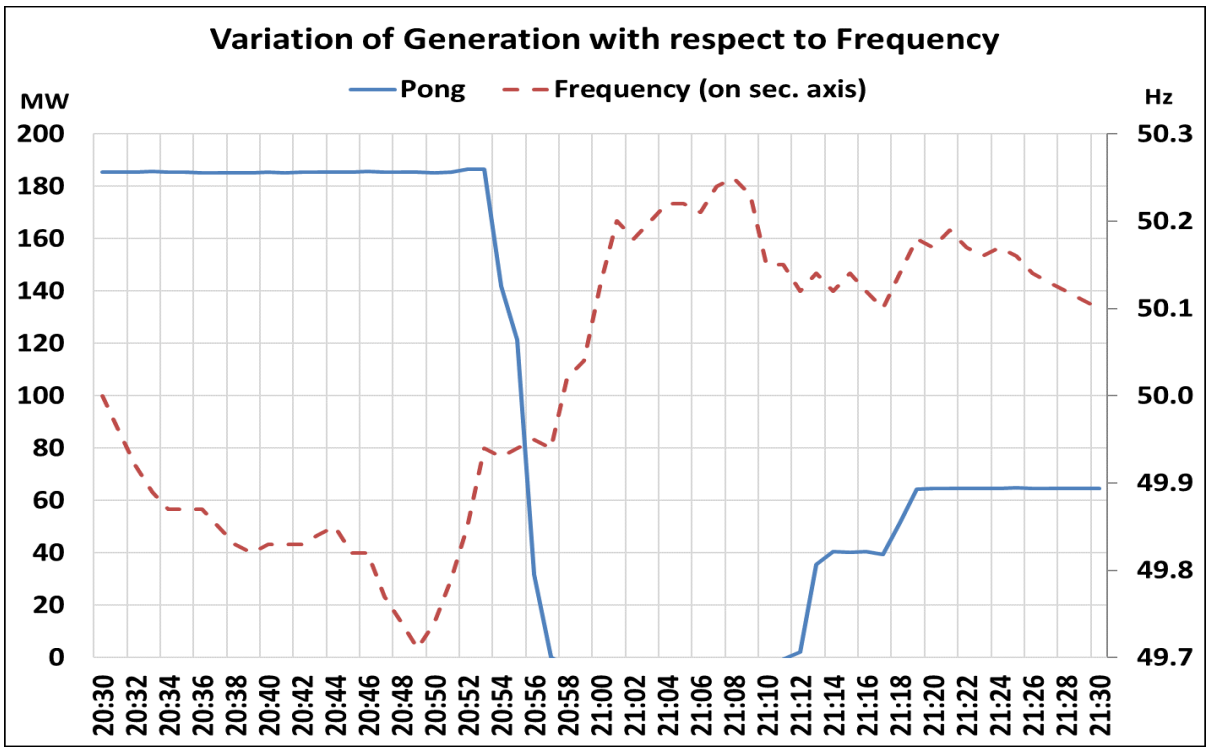
Variation of Generation with respect to Frequency
Pong
Frequency (on sec. axis)
MW
Hz
200
180
160
140
120
100
80
60
40
20
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
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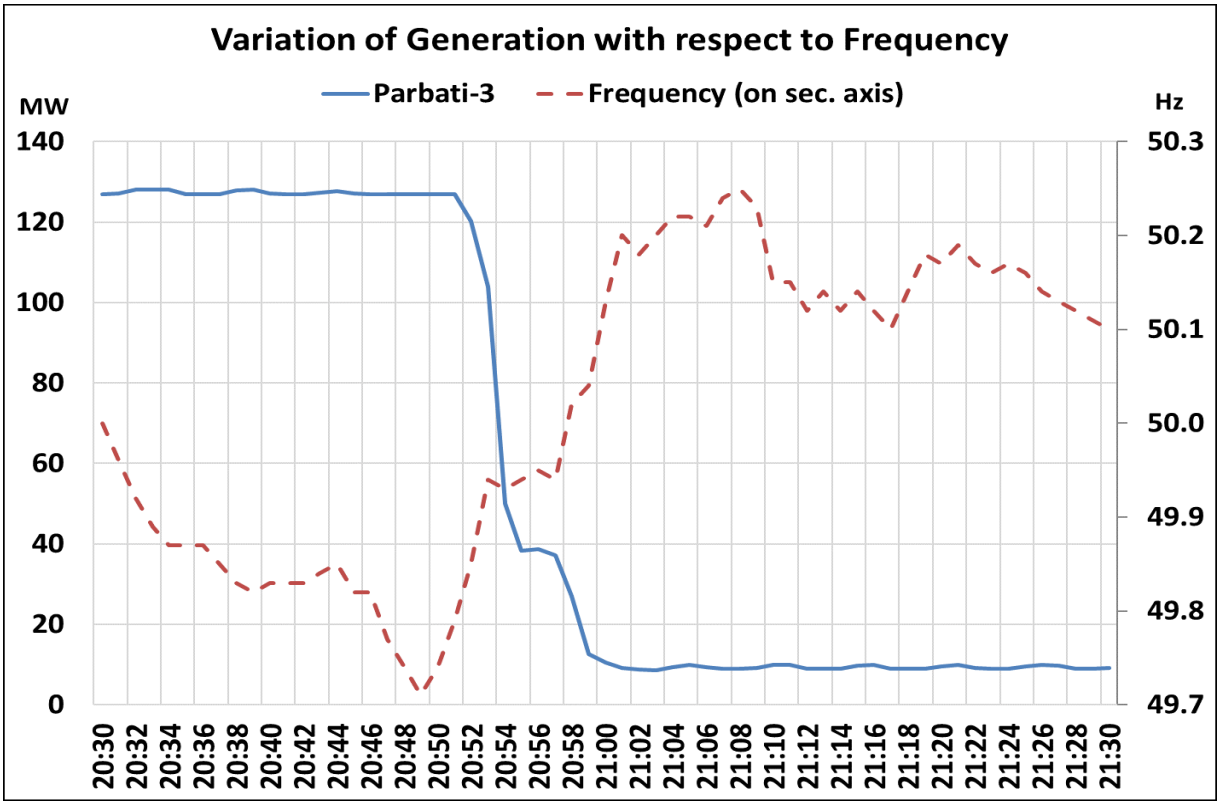
Variation of Generation with respect to Frequency
Parbati-3
Frequency (on sec. axis)
MW
Hz
140
120
100
80
60
40
20
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
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20:44
20:46
20:48
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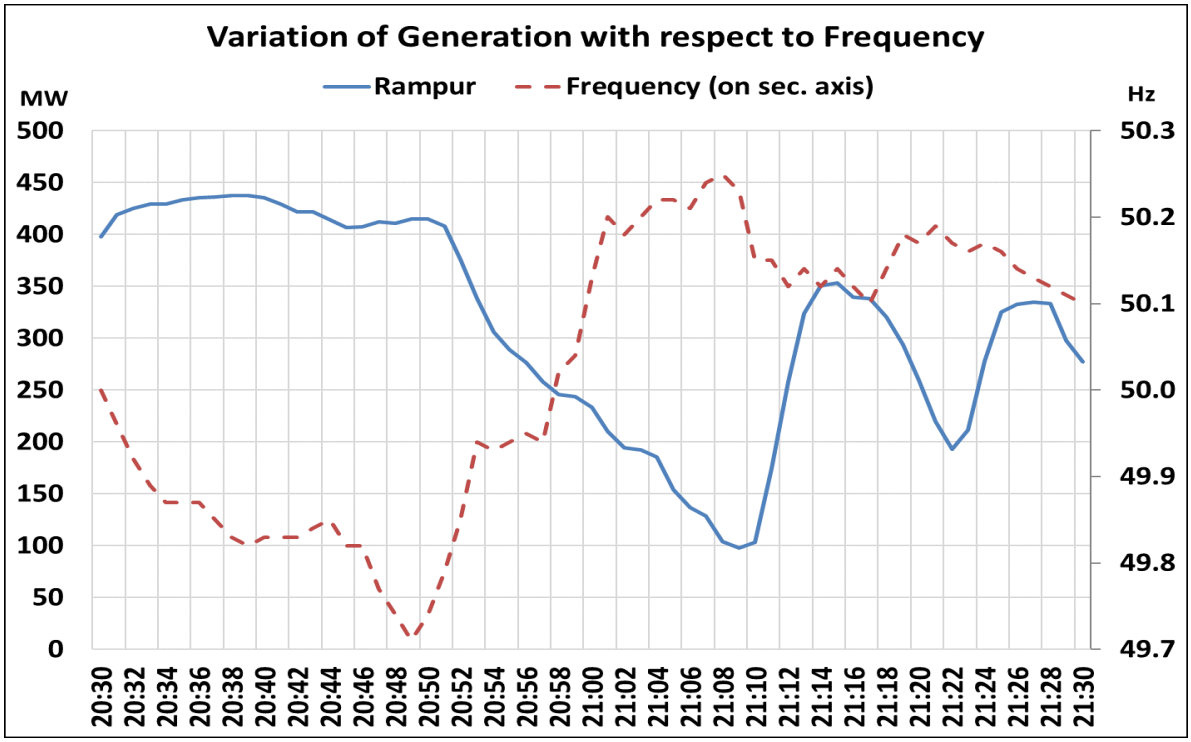
Variation of Generation with respect to Frequency
Rampur
Frequency (on sec. axis)
MW
Hz
500
450
400
350
300
250
200
150
100
50
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
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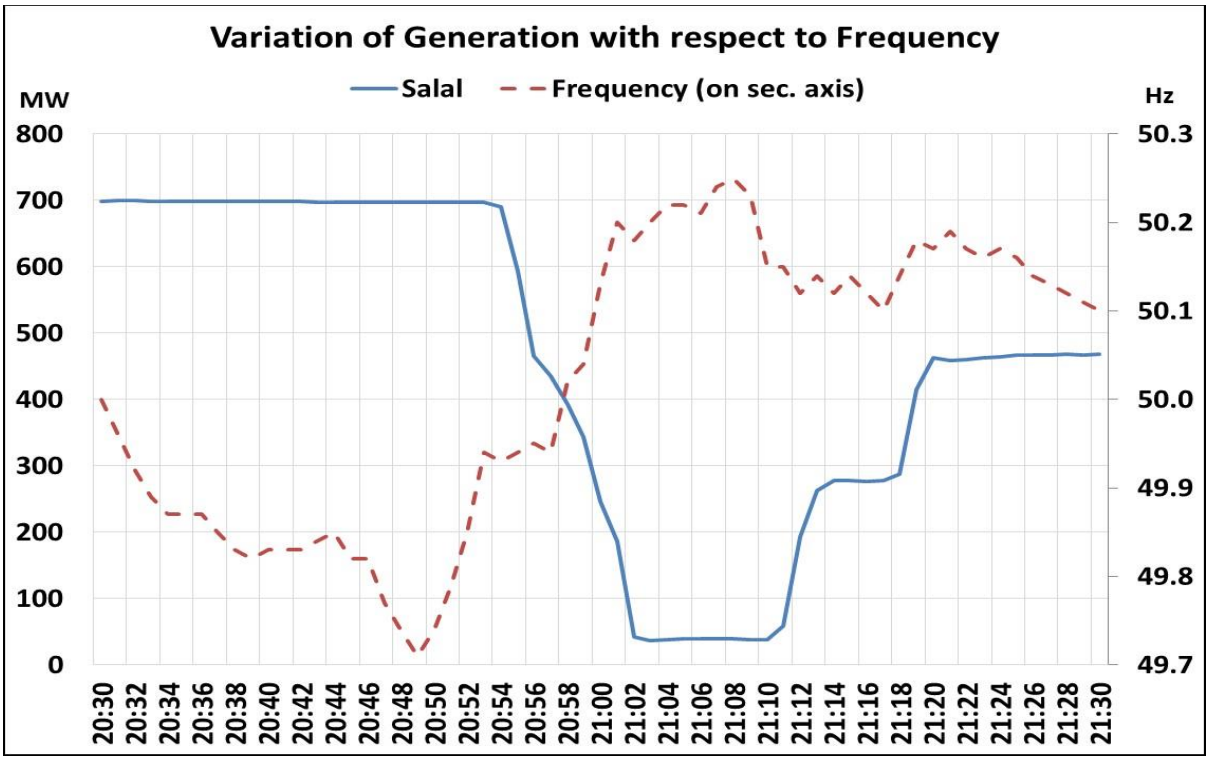
Variation of Generation with respect to Frequency
Salal
Frequency (on sec. axis)
MW
Hz
800
700
600
500
400
300
200
100
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
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20:46
20:48
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20:54
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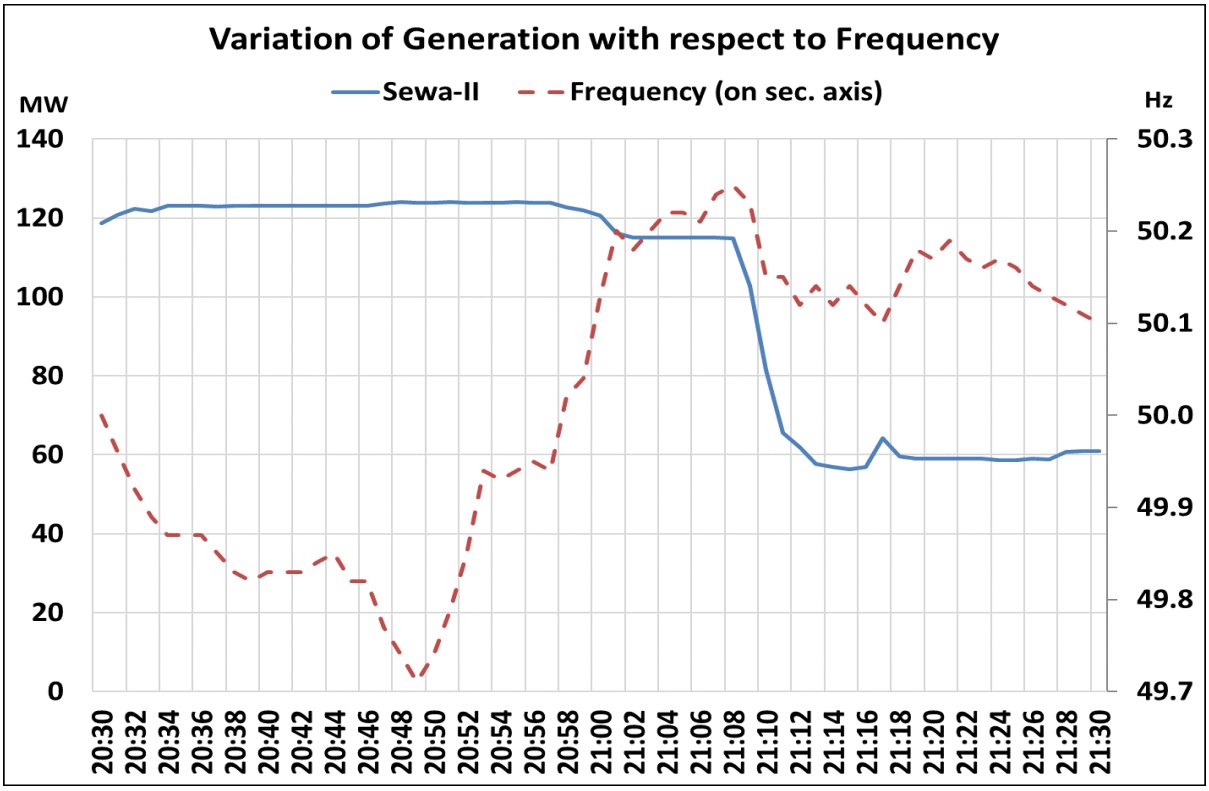
Variation of Generation with respect to Frequency
Sewa-II
Frequency (on sec. axis)
MW
Hz
140
120
100
80
60
40
20
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
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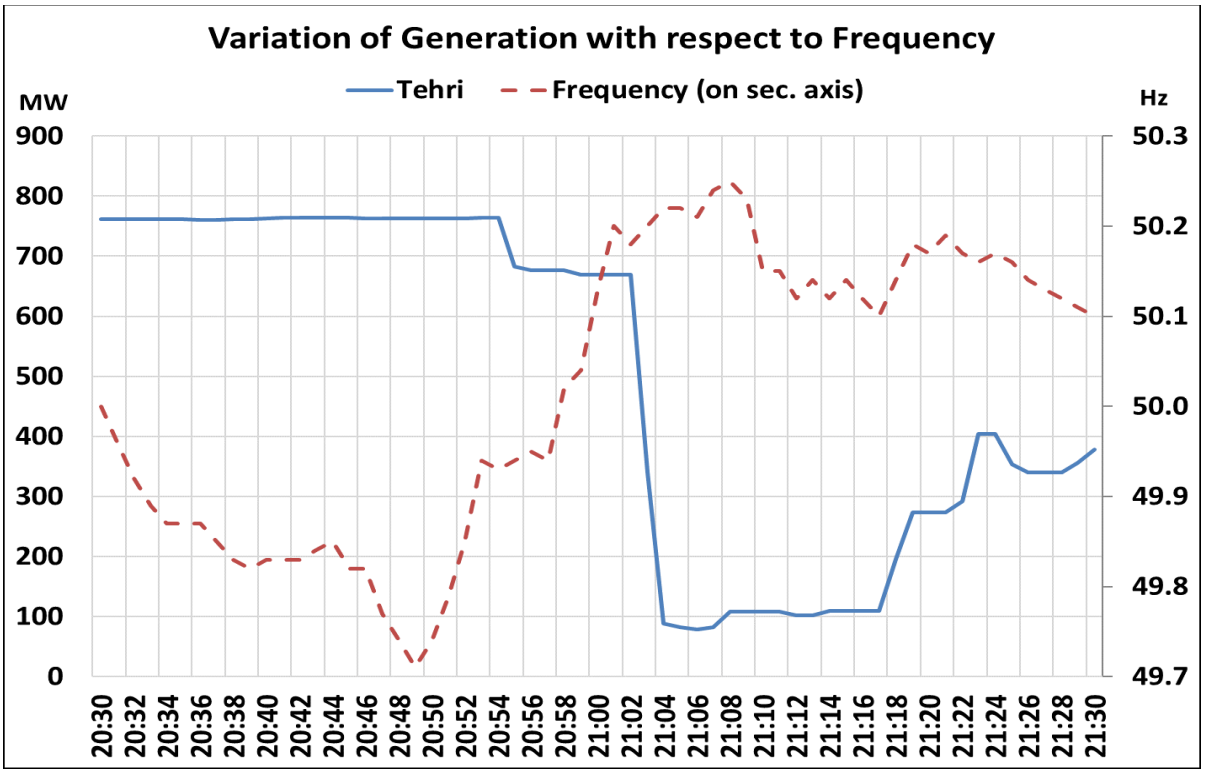
Variation of Generation with respect to Frequency
Tehri
Frequency (on sec. axis)
MW
Hz
900
800
700
600
500
400
300
200
100
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
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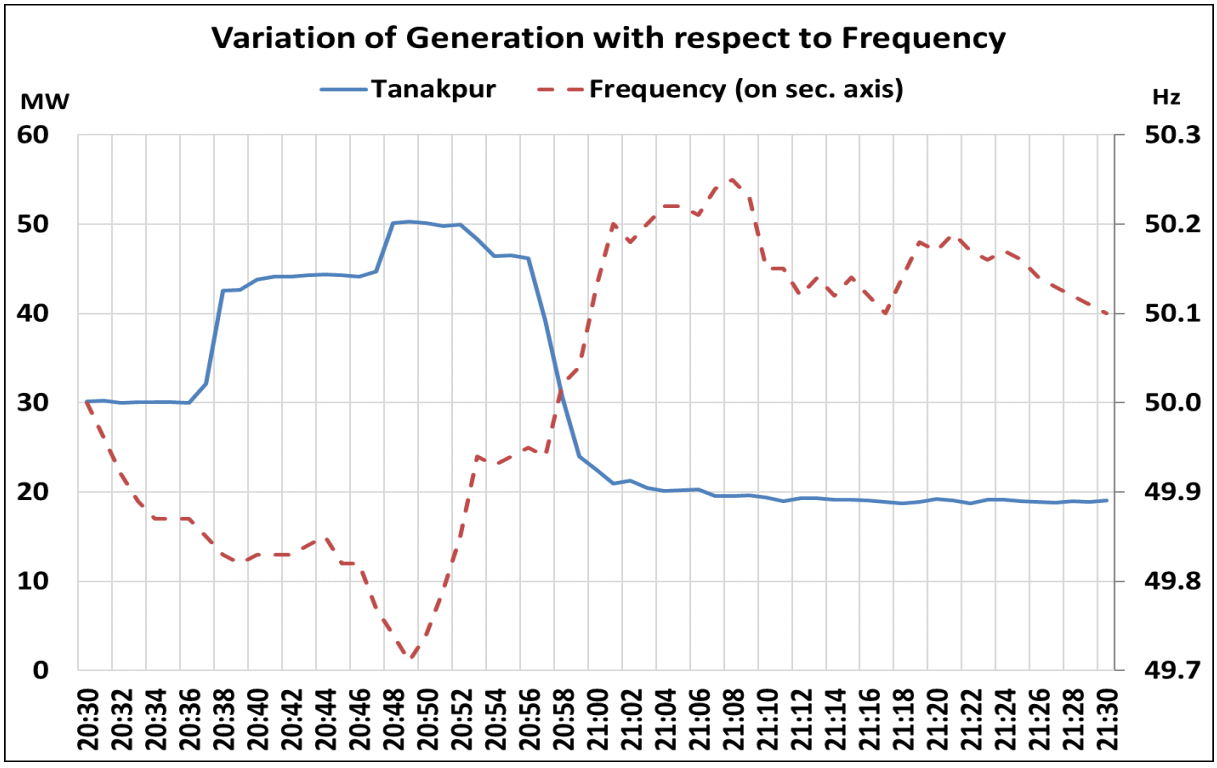
Variation of Generation with respect to Frequency
Tanakpur
Frequency (on sec. axis)
MW
Hz
60
50
40
30
20
10
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
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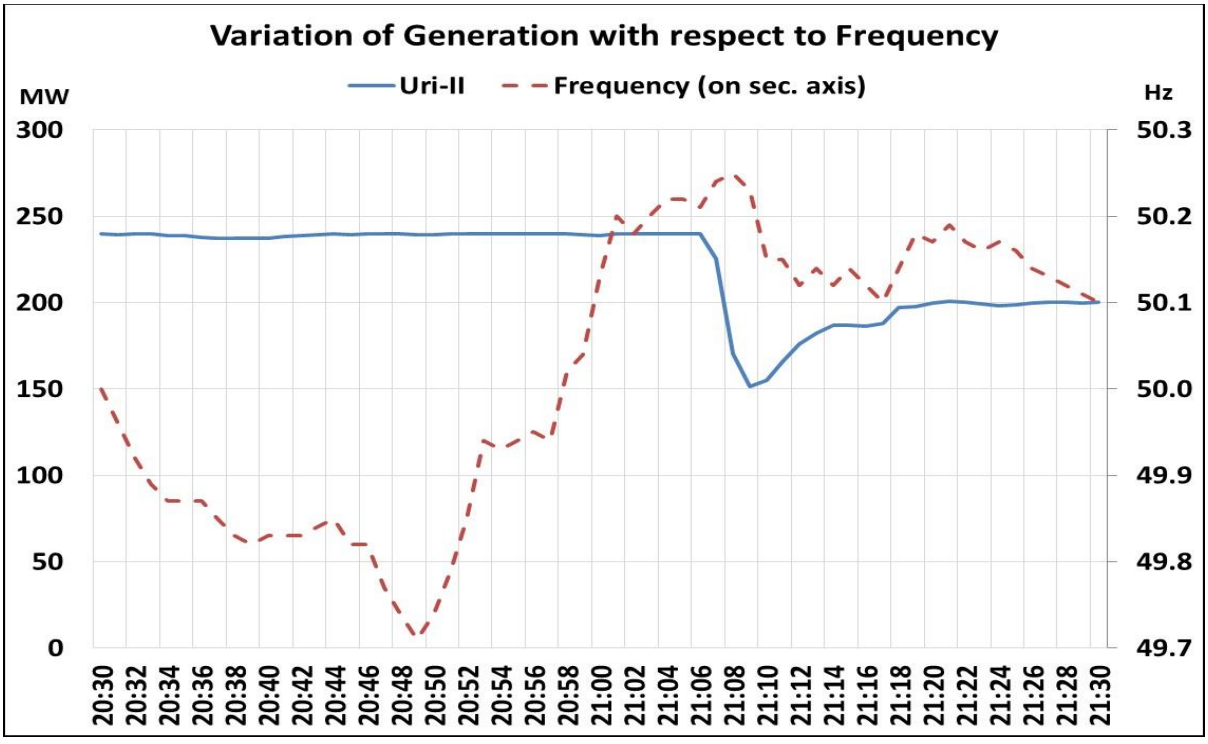
Variation of Generation with respect to Frequency
Uri-II
Frequency (on sec. axis)
MW
Hz
300
250
200
150
100
50
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
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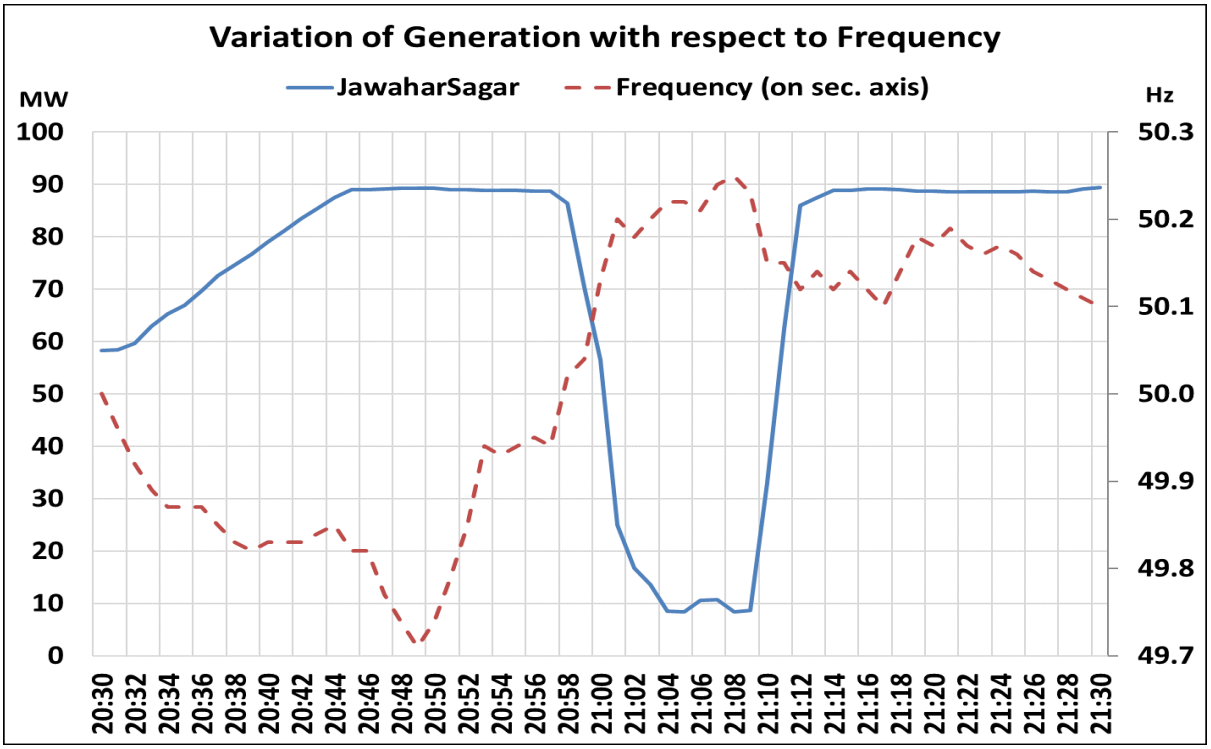
Variation of Generation with respect to Frequency
JawaharSagar
Frequency (on sec. axis)
MW
Hz
100
90
80
70
60
50
40
30
20
10
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
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21:22
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21:28
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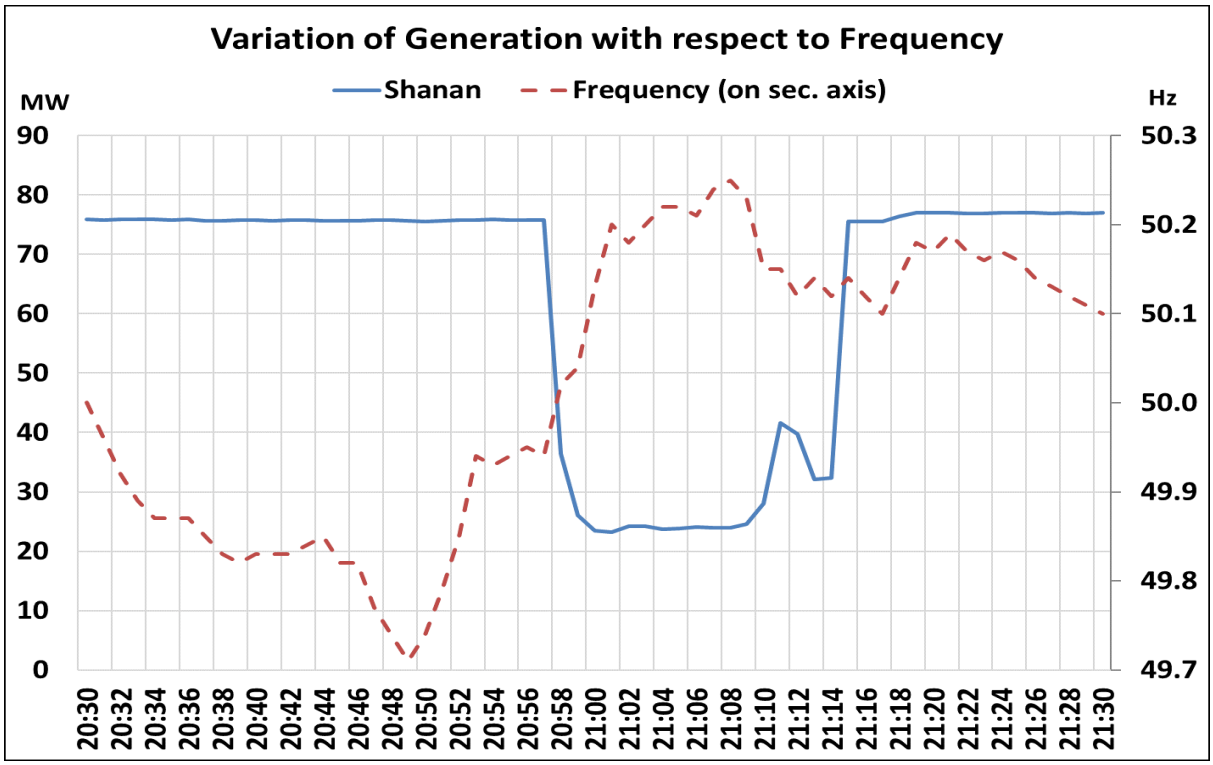
Variation of Generation with respect to Frequency
Shanan
Frequency (on sec. axis)
MW
Hz
90
80
70
60
50
40
30
20
10
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
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20:50
20:52
20:54
20:56
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21:22
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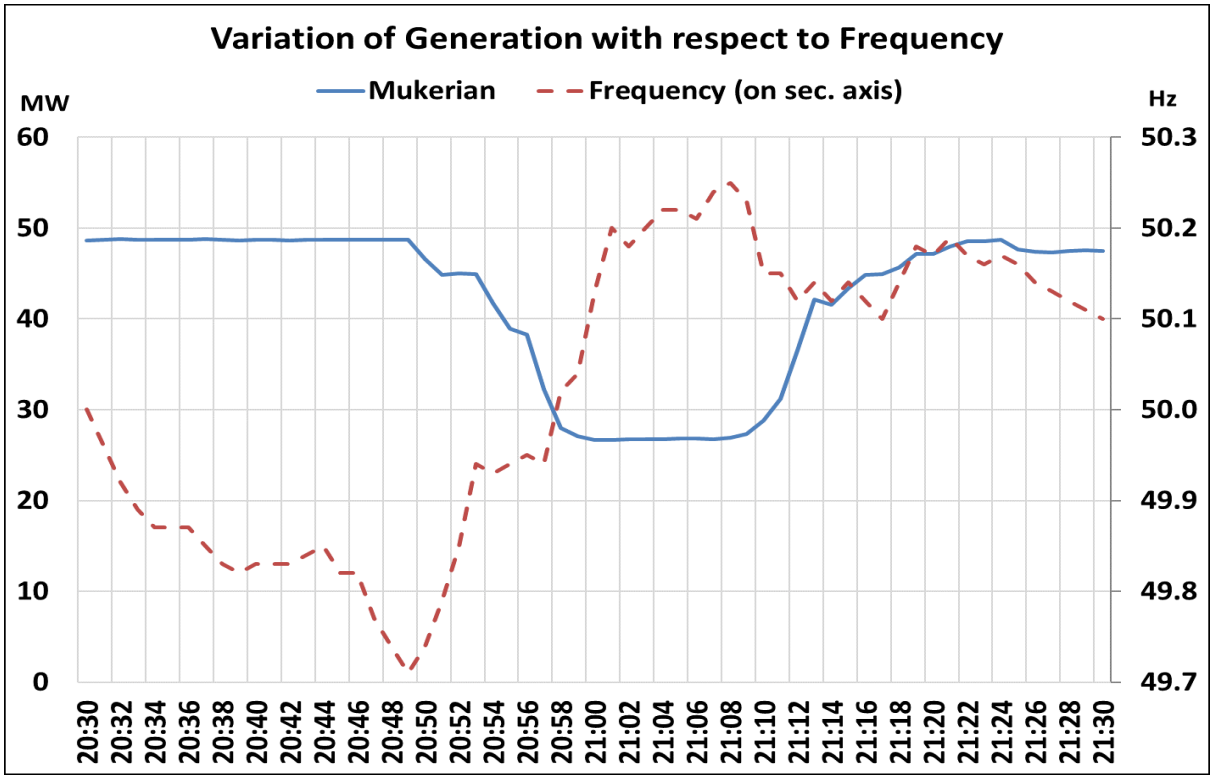
Variation of Generation with respect to Frequency
Mukerian
Frequency (on sec. axis)
MW
Hz
60
50
40
30
20
10
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
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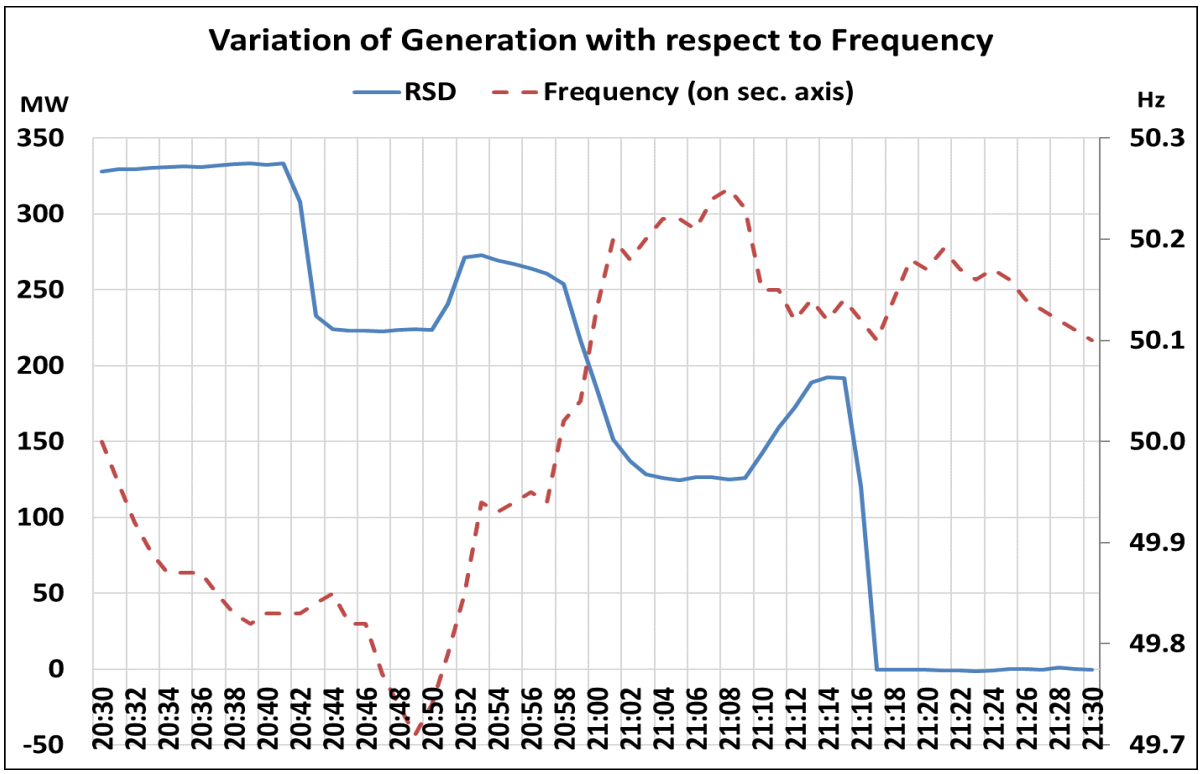
Variation of Generation with respect to Frequency
RSD
Frequency (on sec. axis)
MW
Hz
350
300
250
200
150
100
50
0
-50
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
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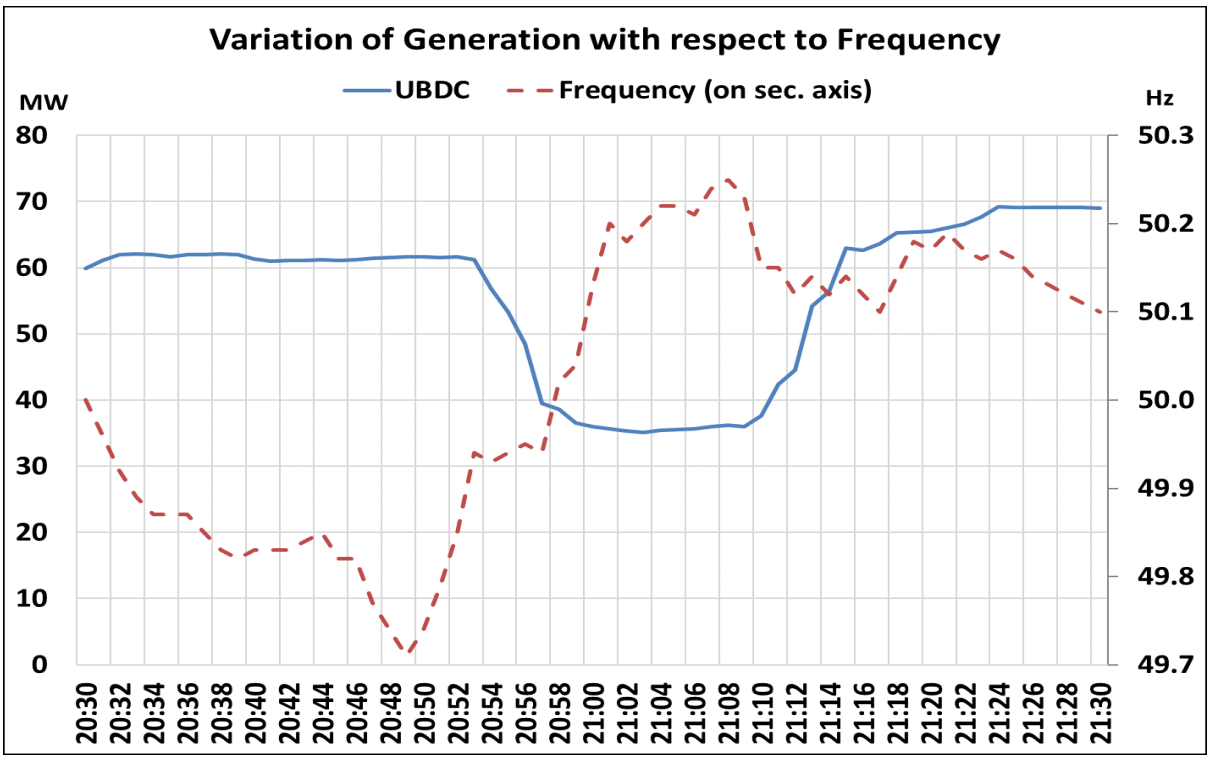
Variation of Generation with respect to Frequency
UBDC
Frequency (on sec. axis)
MW
Hz
80
70
60
50
40
30
20
10
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
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20:42
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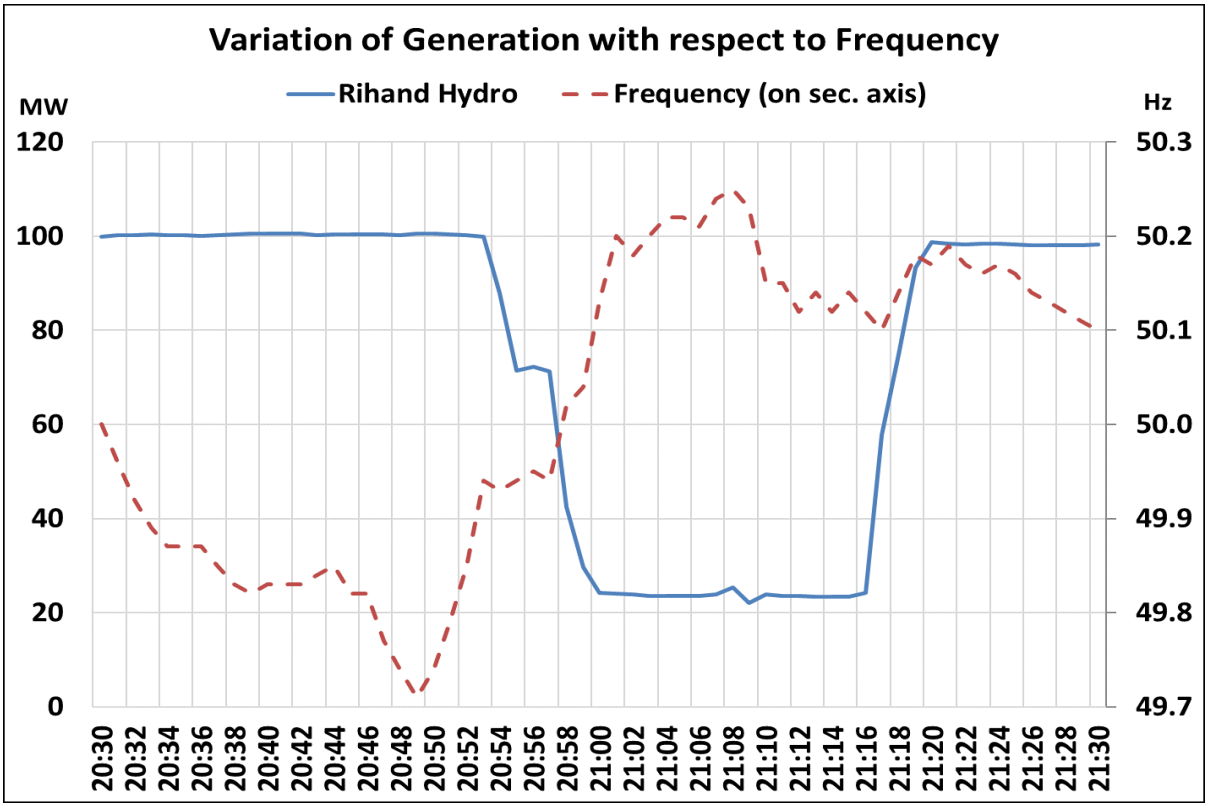
Variation of Generation with respect to Frequency
Rihand Hydro
Frequency (on sec. axis)
MW
Hz
120
100
80
60
40
20
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
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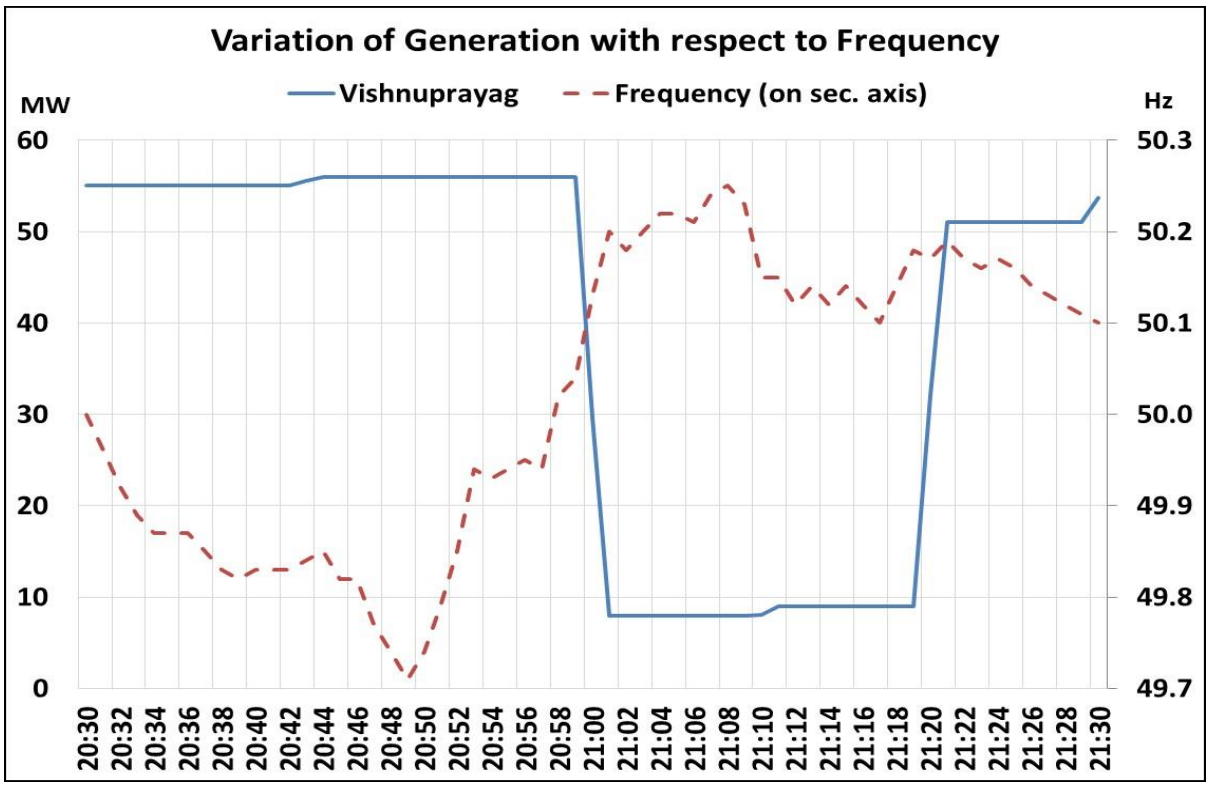
Variation of Generation with respect to Frequency
Vishnuprayag
Frequency (on sec. axis)
MW
Hz
60
50
40
30
20
10
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
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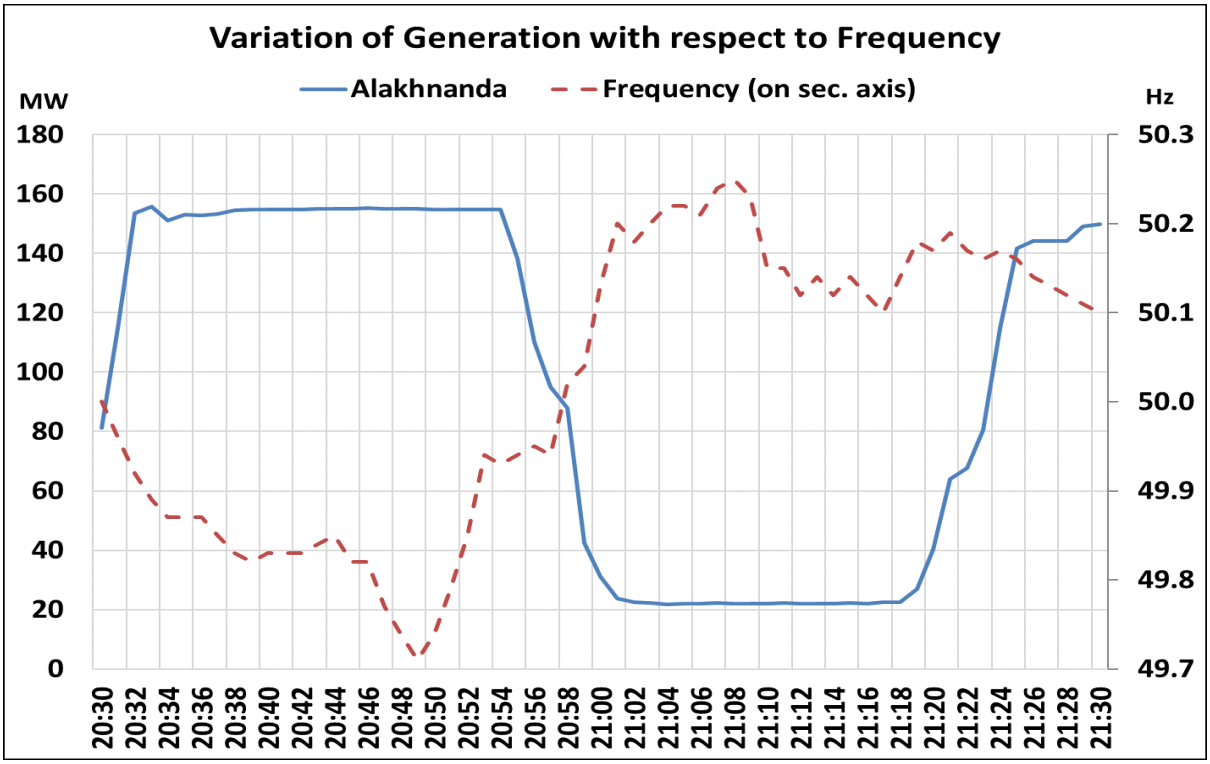
Variation of Generation with respect to Frequency
Alakhnanda
Frequency (on sec. axis)
MW
Hz
180
160
140
120
100
80
60
40
20
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
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21:00
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21:28
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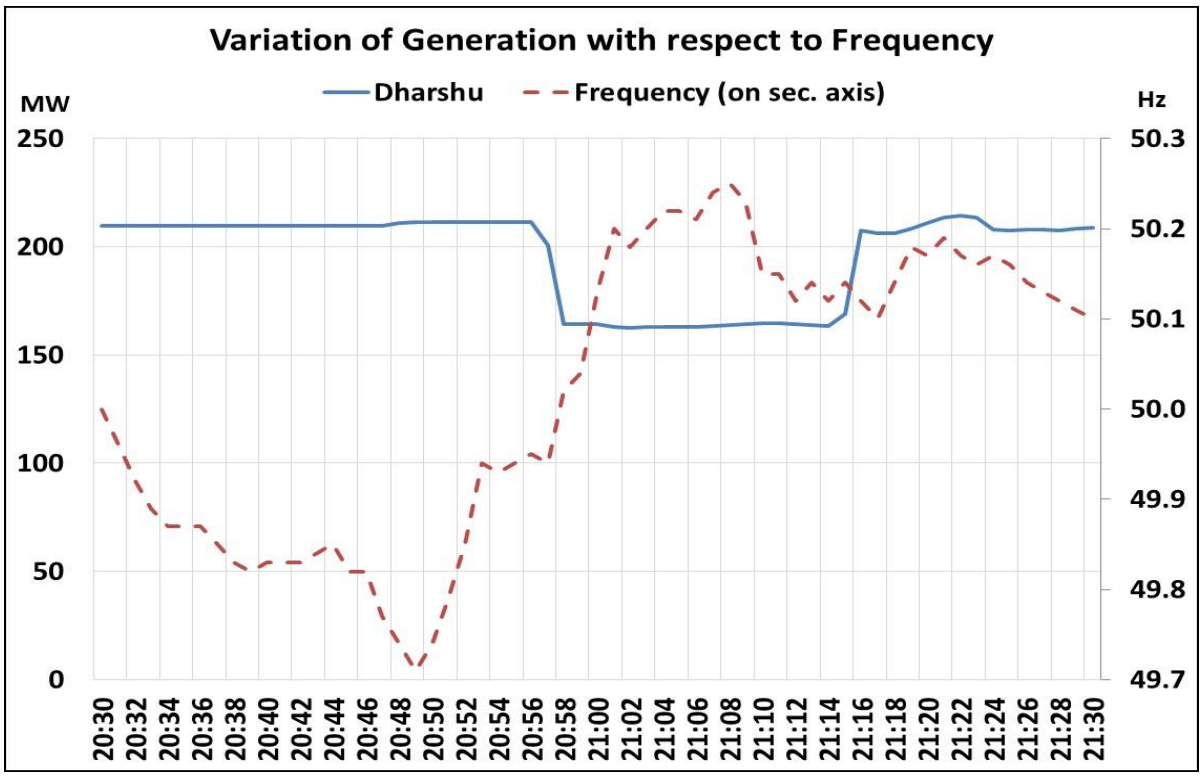
Variation of Generation with respect to Frequency
Dharshu
Frequency (on sec. axis)
MW
Hz
250
200
150
100
50
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
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21:28
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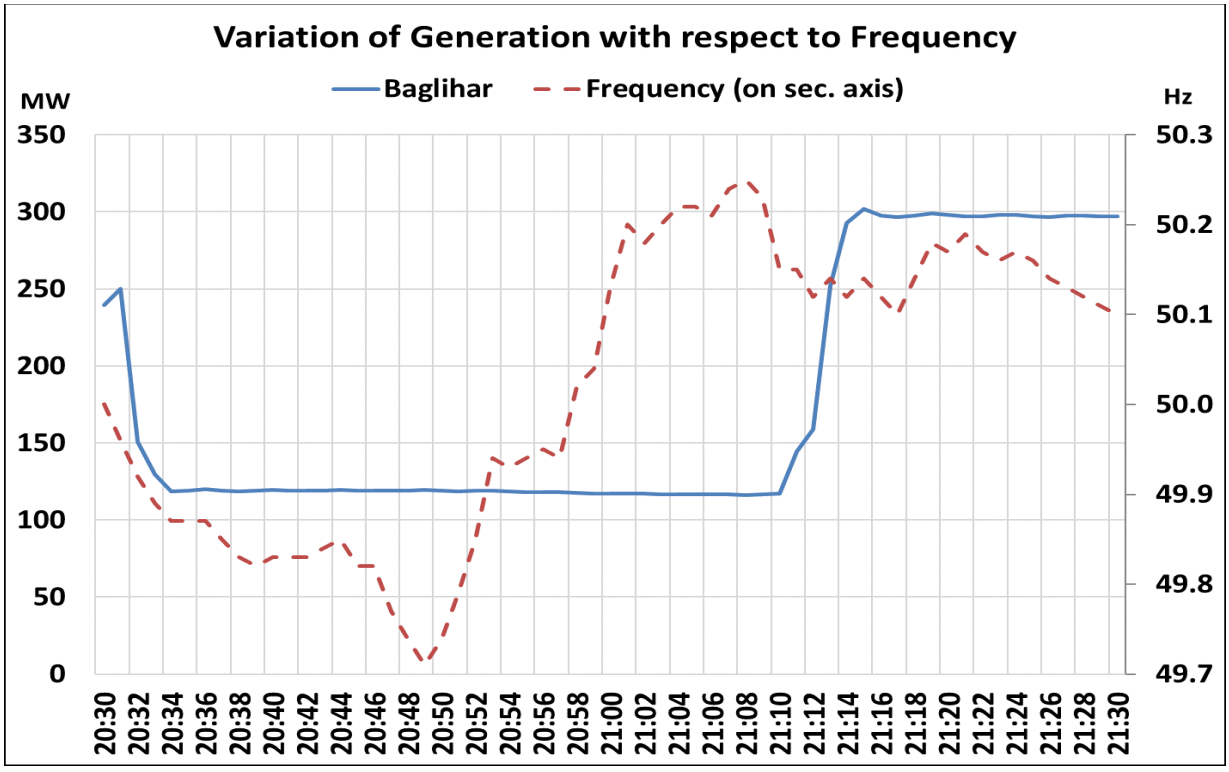
Variation of Generation with respect to Frequency
Baglihar
Frequency (on sec. axis)
MW
Hz
350
300
250
200
150
100
50
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
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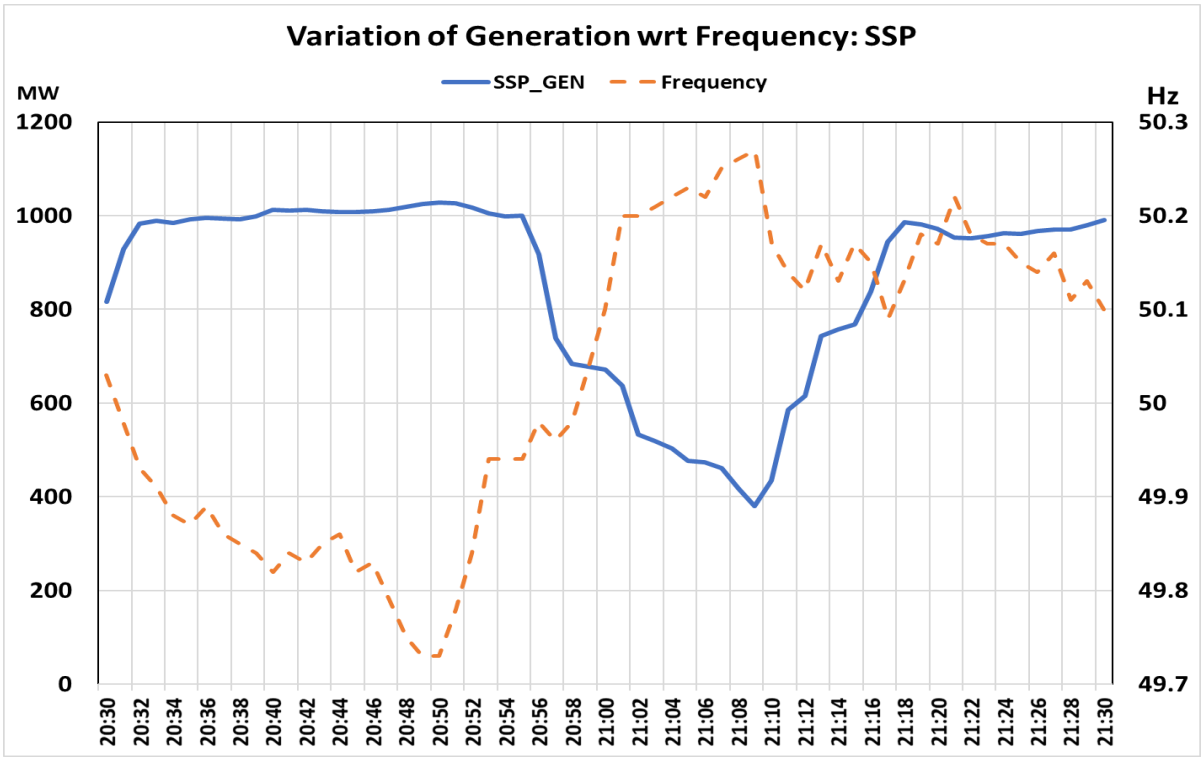
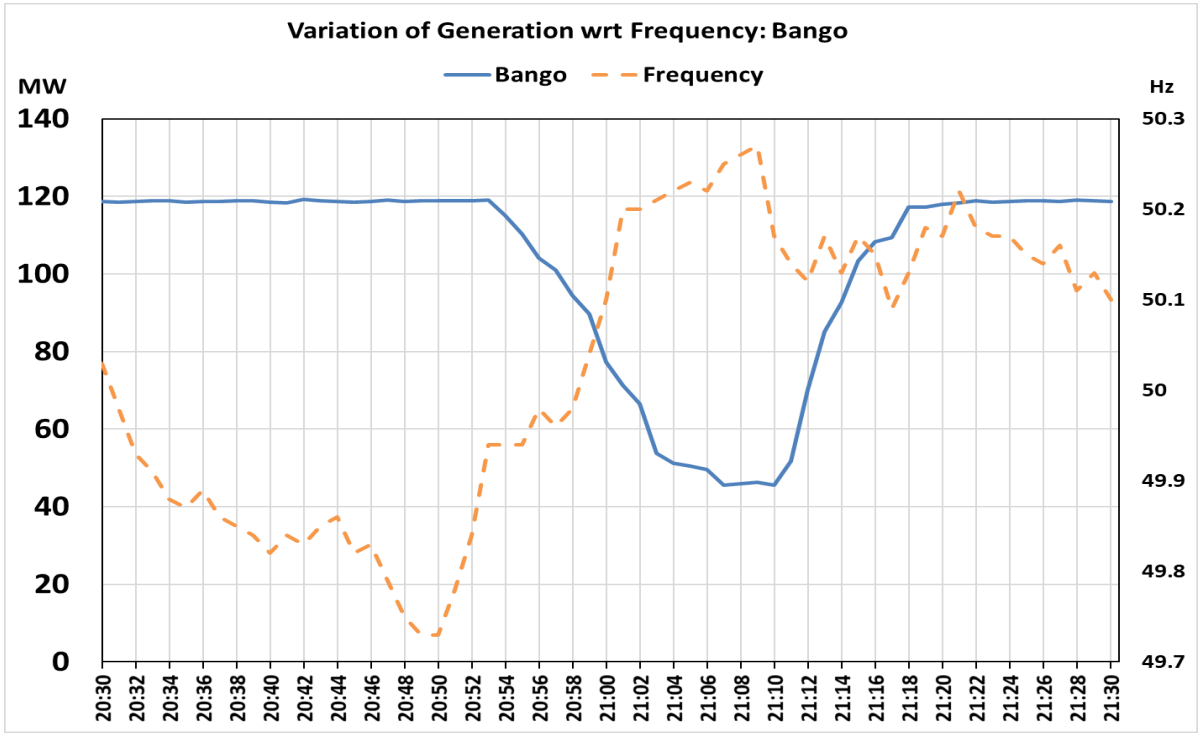
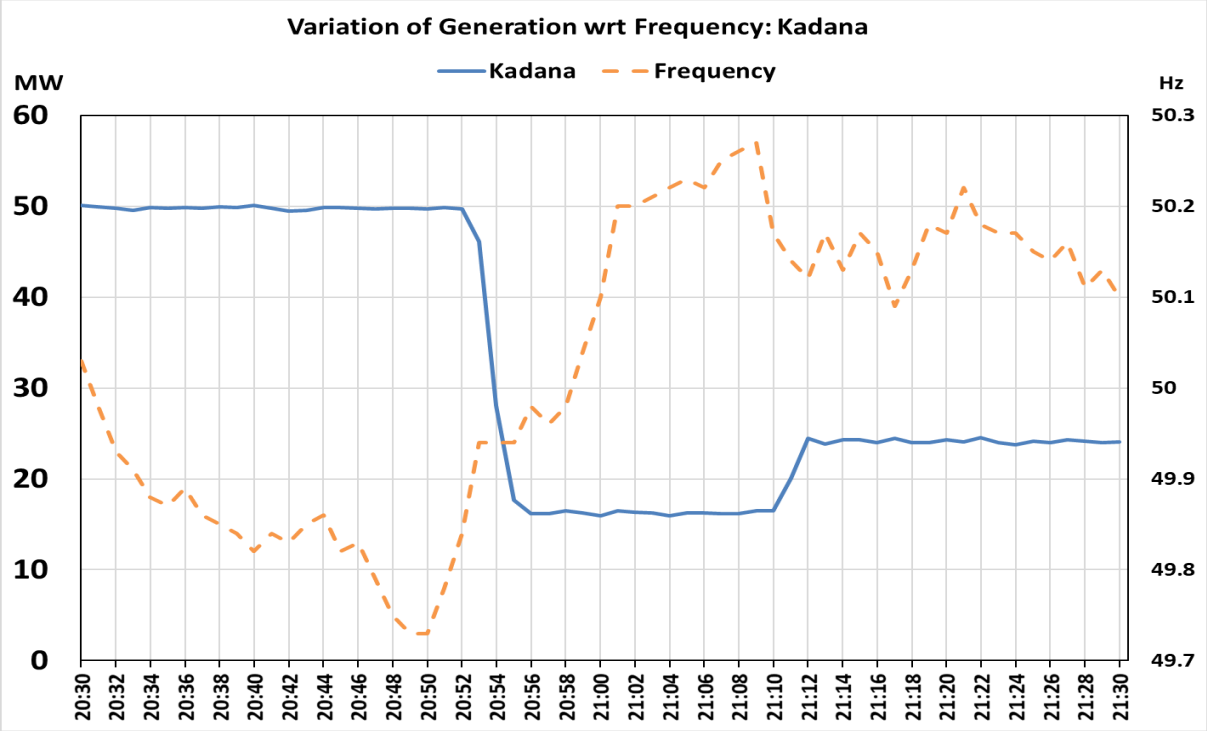
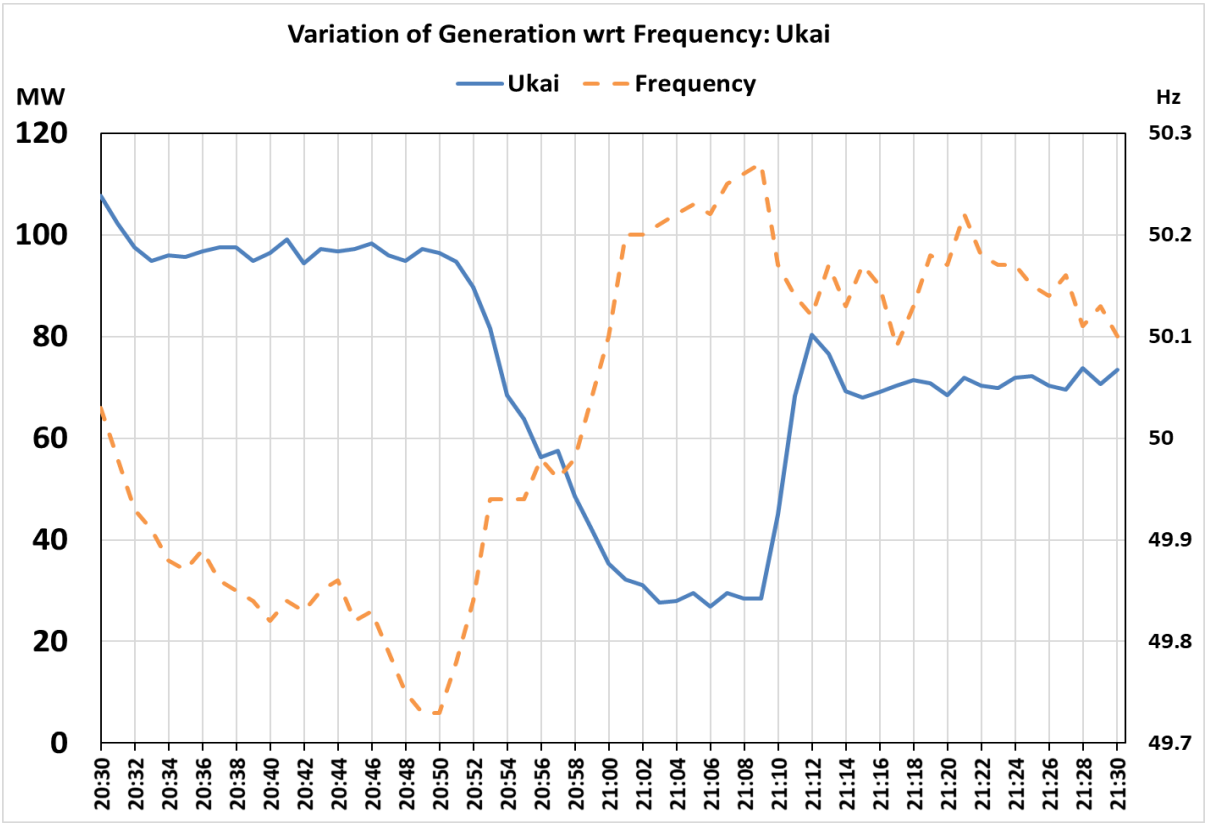
Western Region






Variation of Generation wrt Frequency: Kadana
Kadana
Frequency
MW
Hz
60
50
40
30
20
10
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation wrt Frequency: Ukai
Ukai
Frequency
MW
Hz
120
100
80
60
40
20
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
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20:50
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21:28
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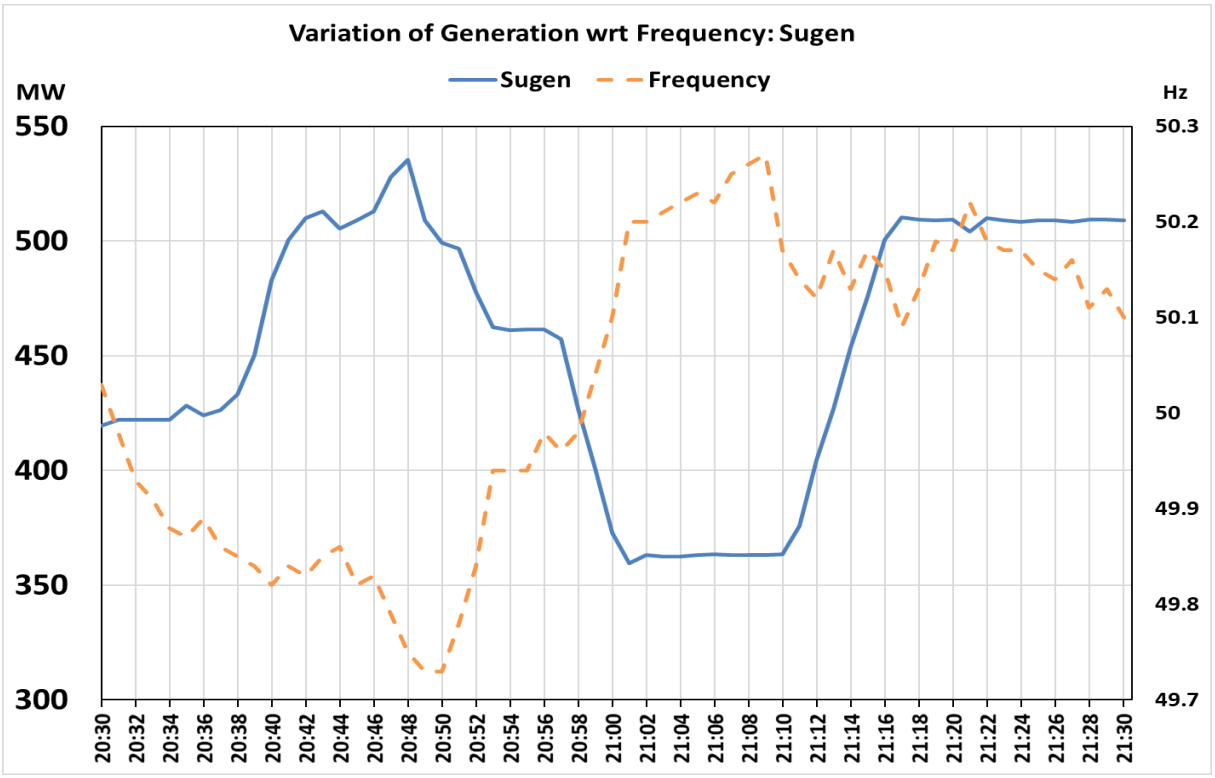
Variation of Generation wrt Frequency: Sugen
Sugen
Frequency
MW
Hz
550
500
450
400
350
300
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
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21:22
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21:28
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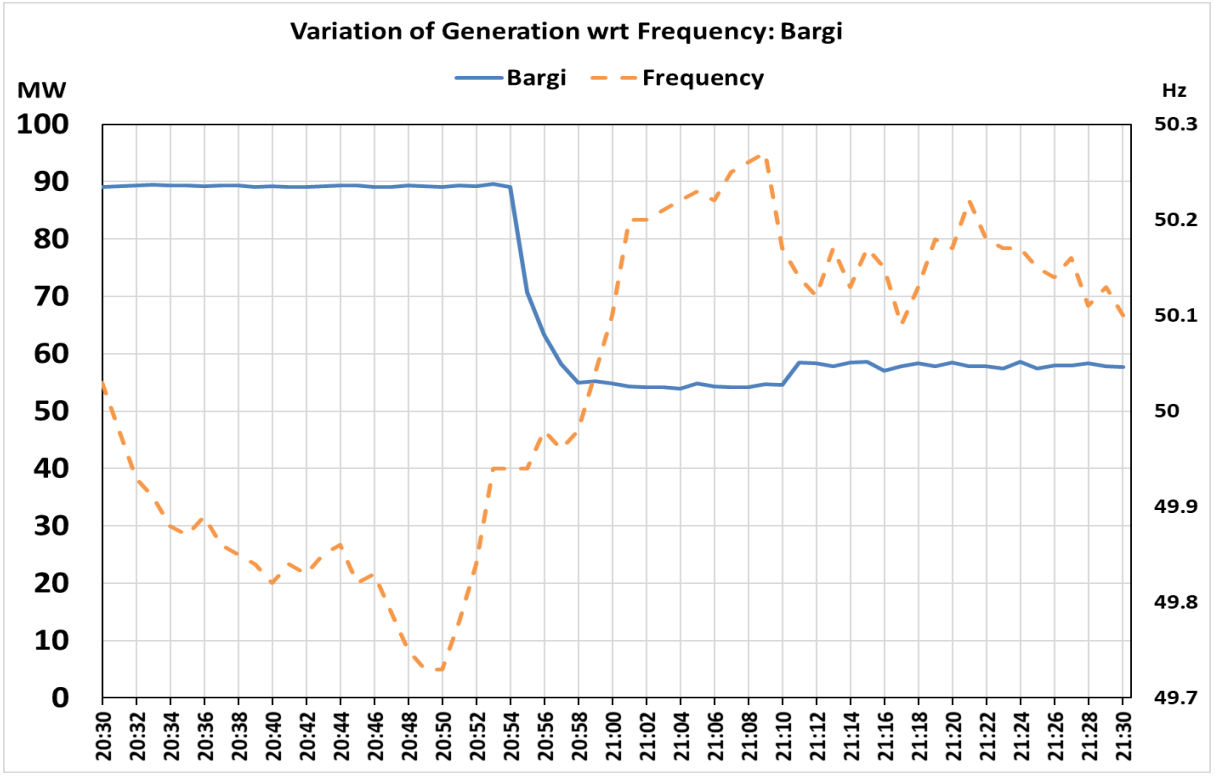
Variation of Generation wrt Frequency: Bargi
Bargi
Frequency
MW
Hz
100
90
80
70
60
50
40
30
20
10
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
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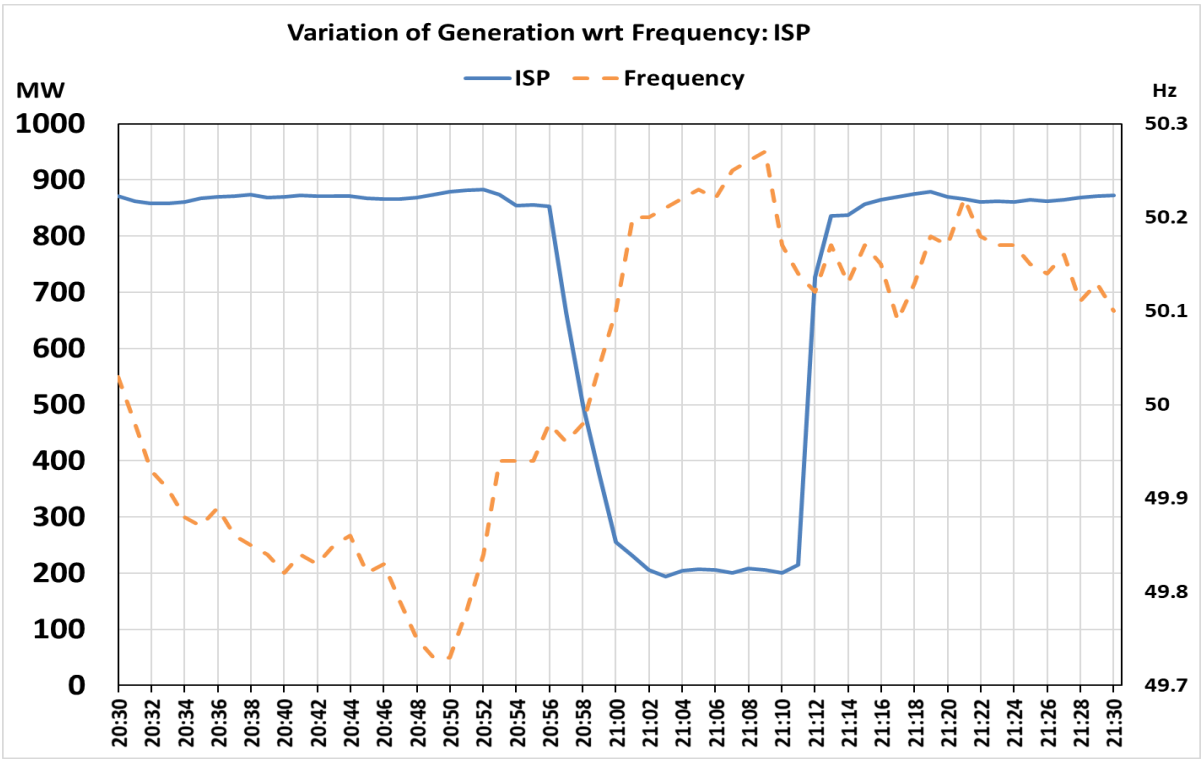
Variation of Generation wrt Frequency: ISP
ISP
Frequency
MW
Hz
1000
900
800
700
600
500
400
300
200
100
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
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20:50
20:52
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21:24
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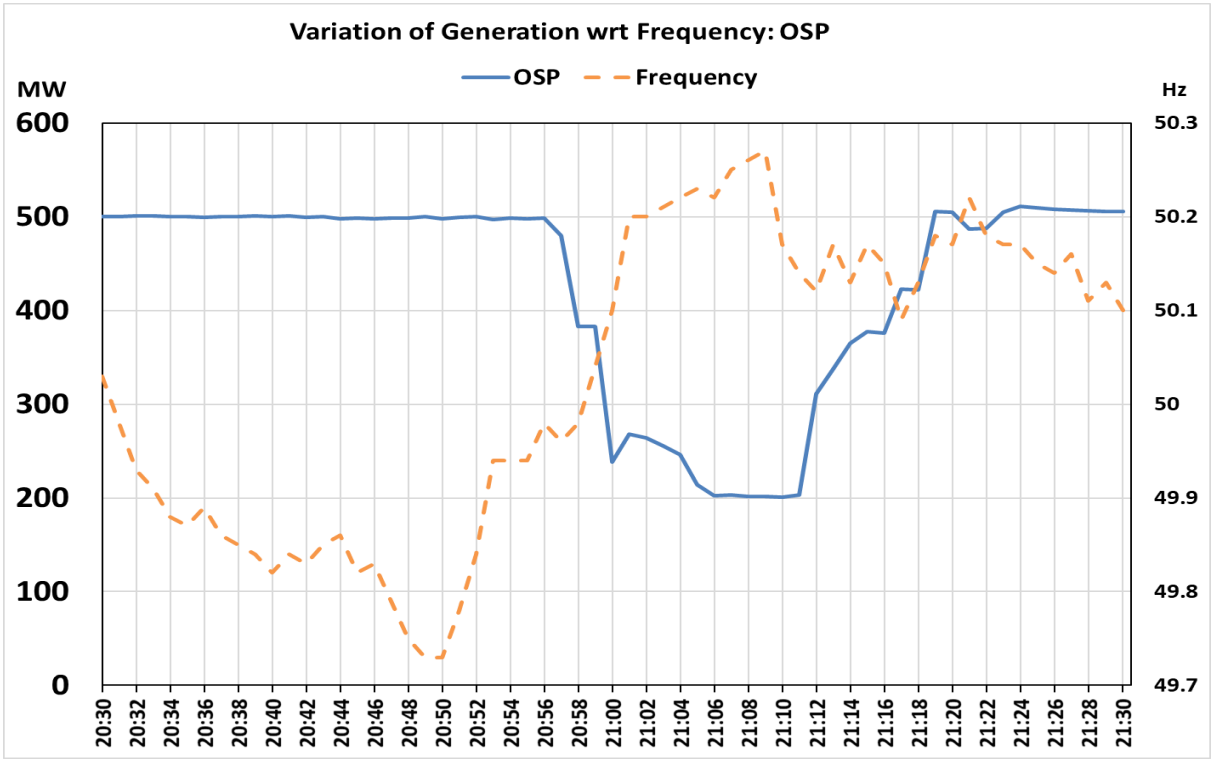
21:28
21:30


Variation of Generation wrt Frequency: OSP
OSP
Frequency
MW
Hz
600
500
400
300
200
100
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
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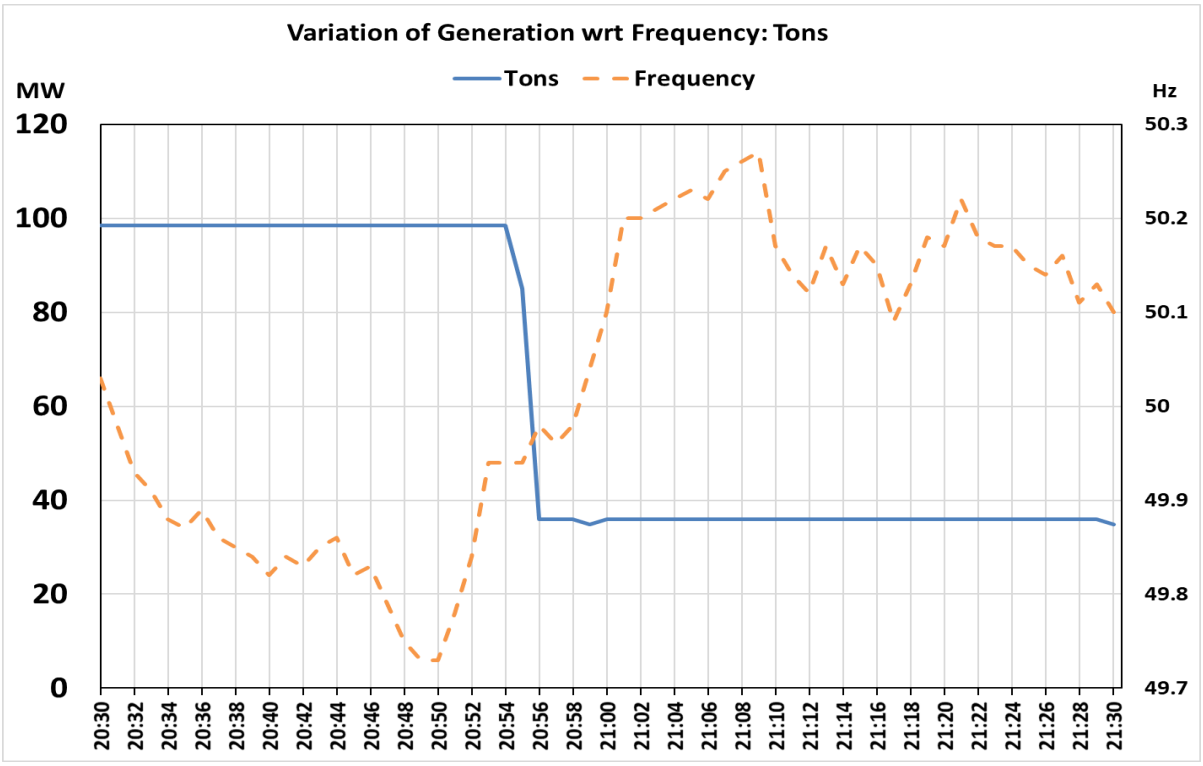
21:28
21:30


Variation of Generation wrt Frequency: Tons
Tons
Frequency
MW
Hz
120
100
80
60
40
20
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
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20:40
20:42
20:44
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20:54
20:56
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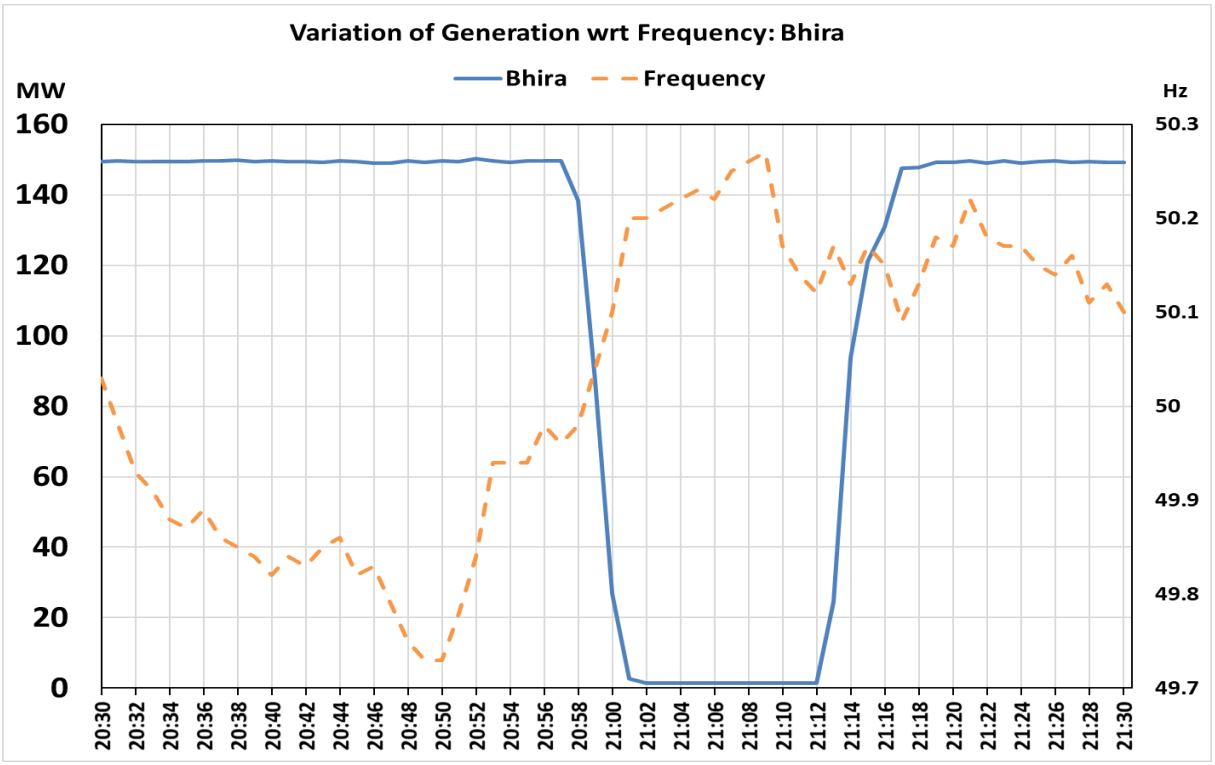
21:30


Variation of Generation wrt Frequency: Bhira
Bhira
Frequency
MW
Hz
160
140
120
100
80
60
40
20
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
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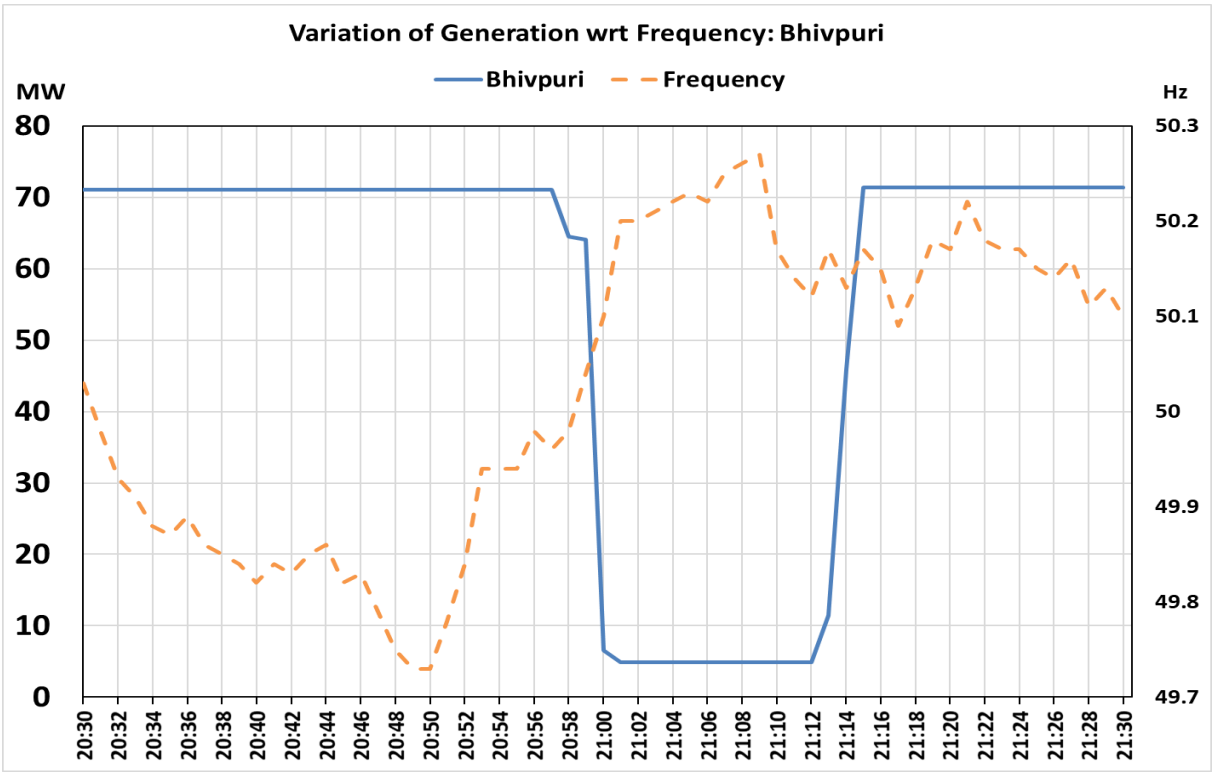
Variation of Generation wrt Frequency: Bhivpuri
Bhivpuri
Frequency
MW
Hz
80
70
60
50
40
30
20
10
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
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21:18
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21:22
21:24
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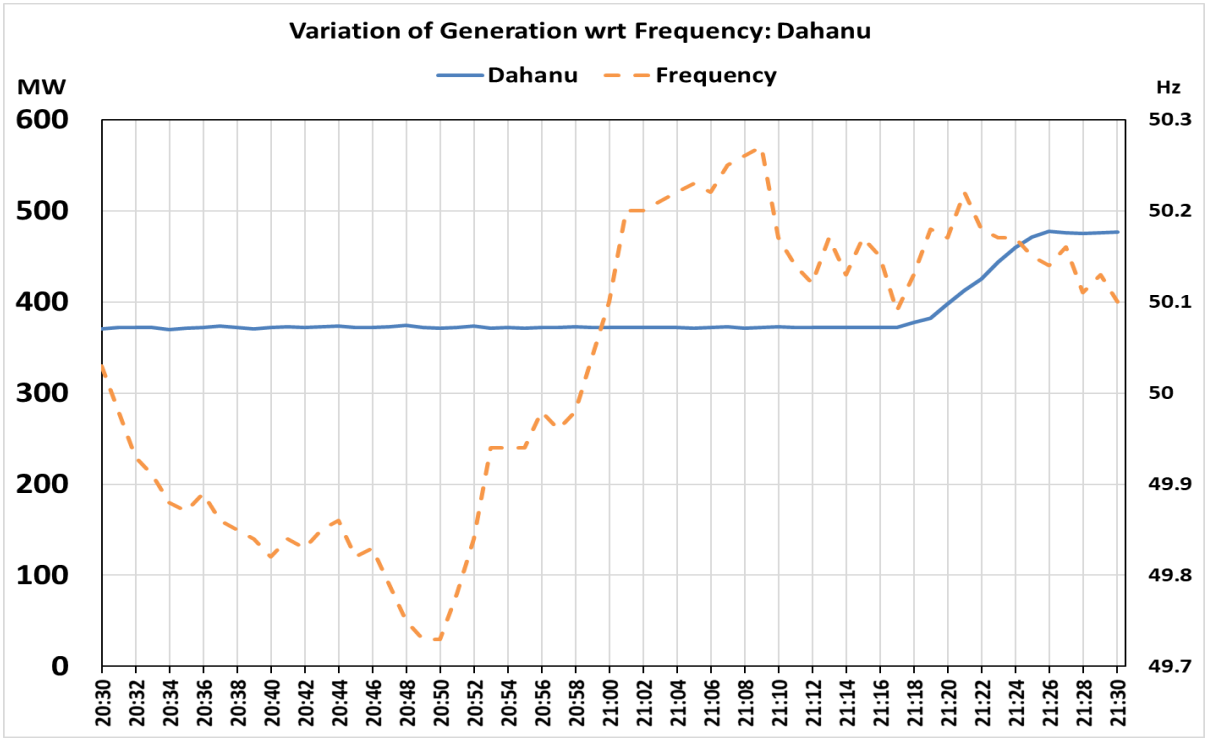
Variation of Generation wrt Frequency: Dahanu
Dahanu
Frequency
MW
Hz
600
500
400
300
200
100
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
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20:46
20:48
20:50
20:52
20:54
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21:22
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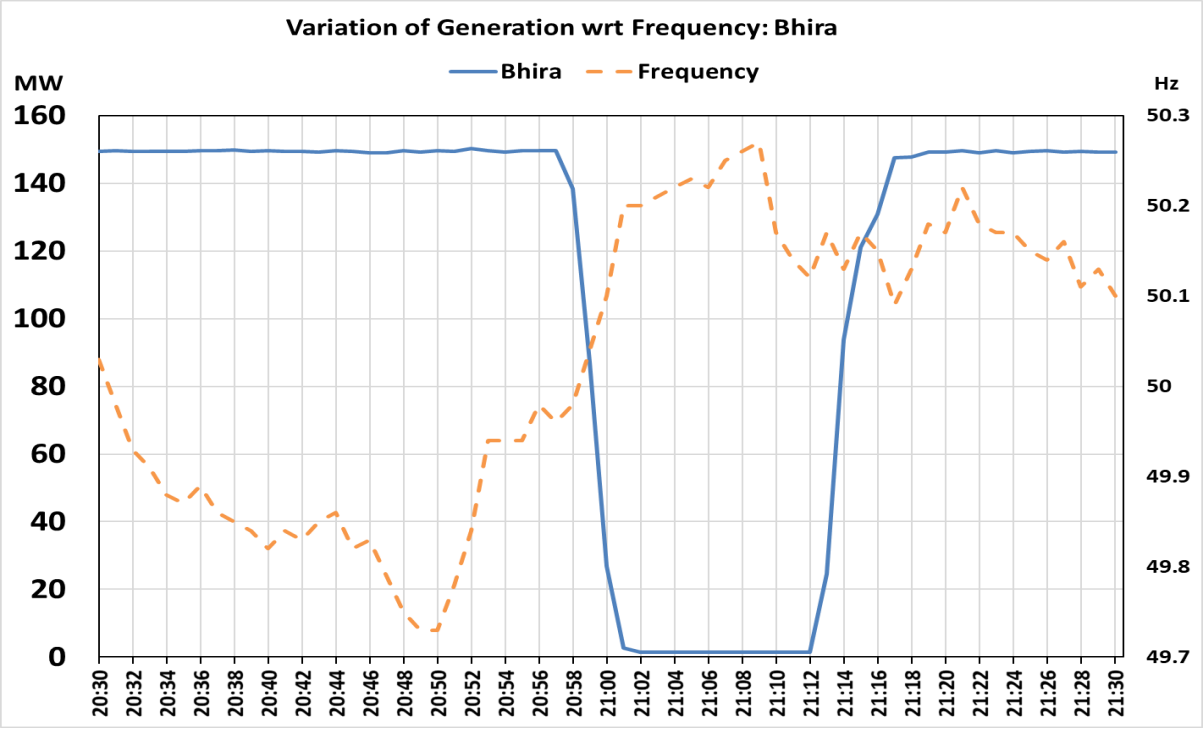
21:30


Variation of Generation wrt Frequency: Bhira
Bhira
Frequency
MW
Hz
160
140
120
100
80
60
40
20
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
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21:08
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21:22
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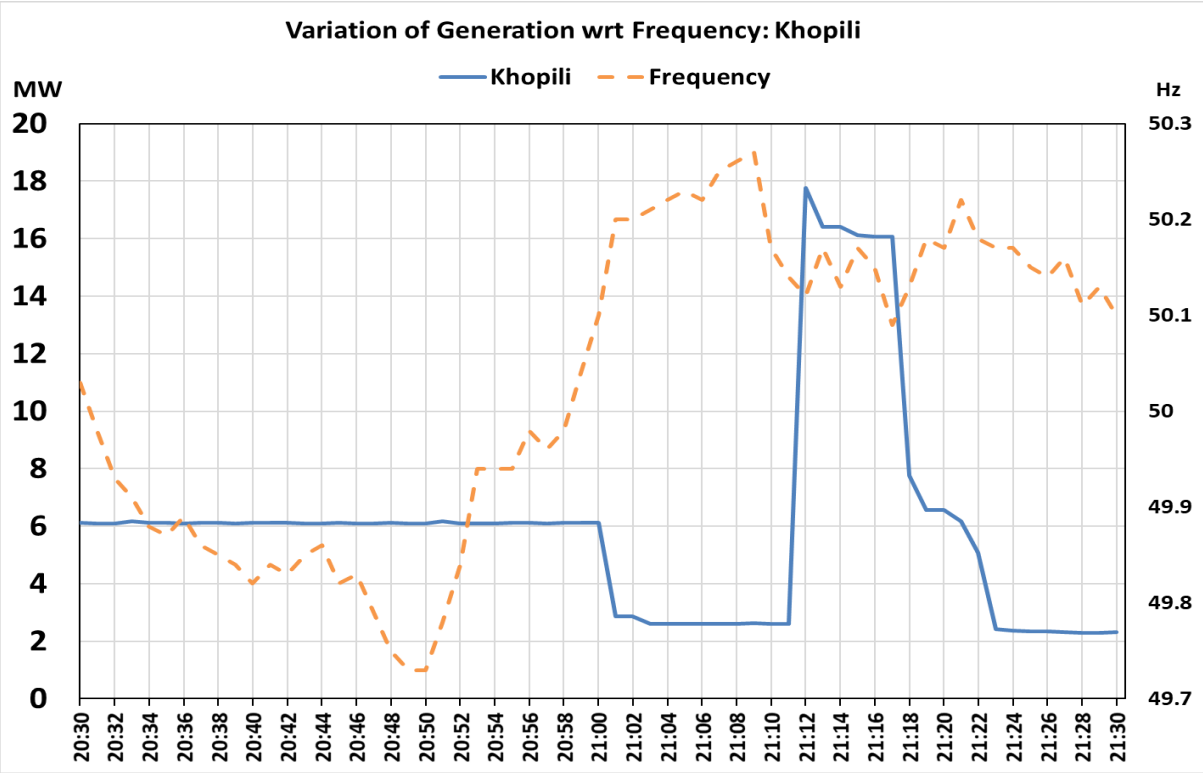
Variation of Generation wrt Frequency: Khopili
Khopili
Frequency
MW
Hz
20
18
16
14
12
10
8
6
4
2
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
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21:04
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21:22
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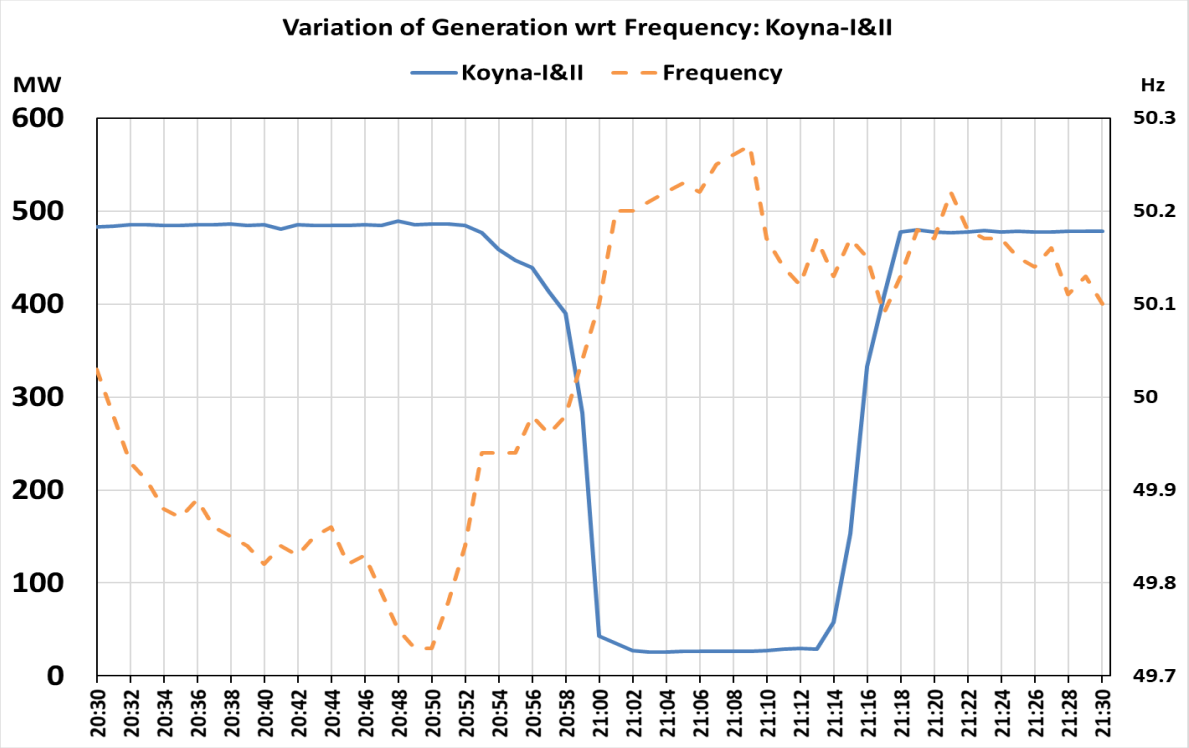
Variation of Generation wrt Frequency: Koyna-I&II
Koyna-I&II
Frequency
MW
Hz
600
500
400
300
200
100
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
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21:04
21:06
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21:18
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21:22
21:24
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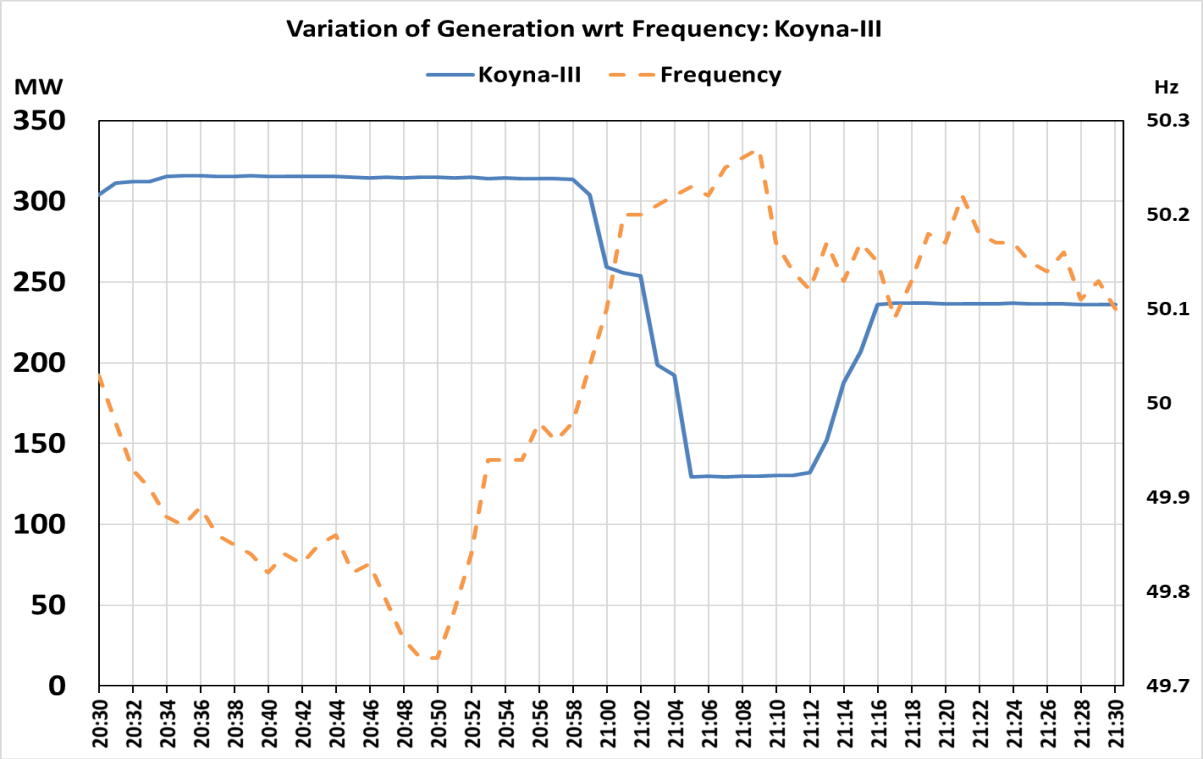
Variation of Generation wrt Frequency: Koyna-III
Koyna-III
Frequency
MW
Hz
350
300
250
200
150
100
50
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
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21:02
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21:18
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21:22
21:24
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21:28
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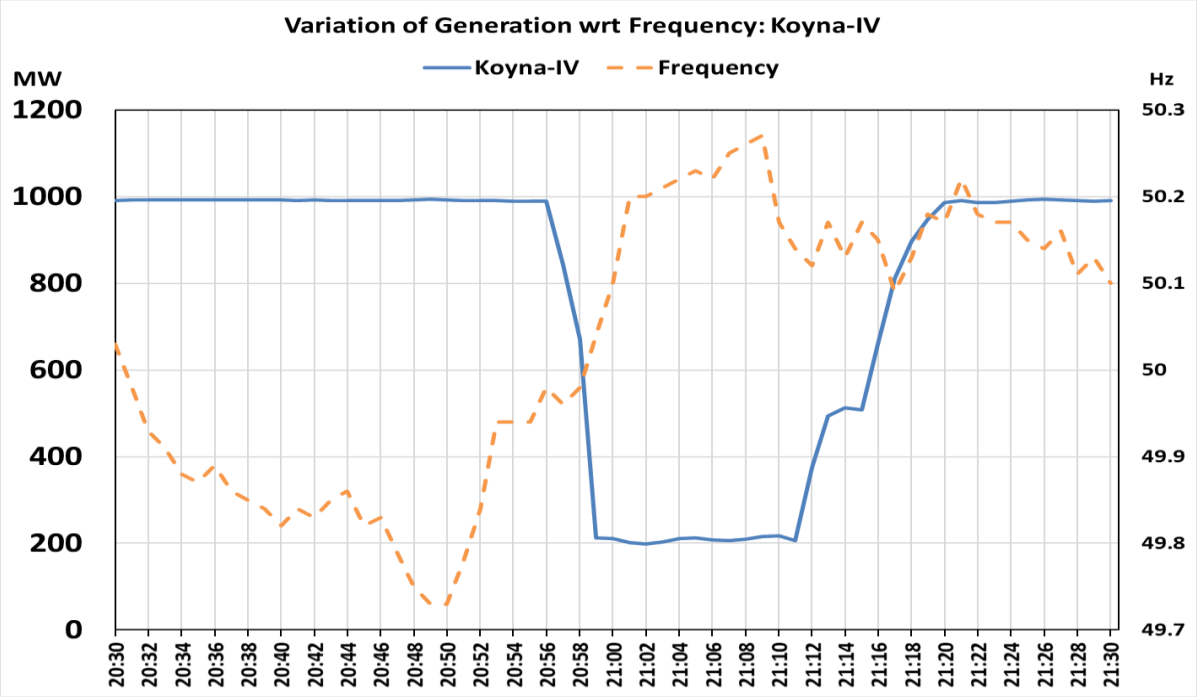
Variation of Generation wrt Frequency: Koyna-IV
Koyna-IV
Frequency
MW
Hz
1200
1000
800
600
400
200
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
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20:56
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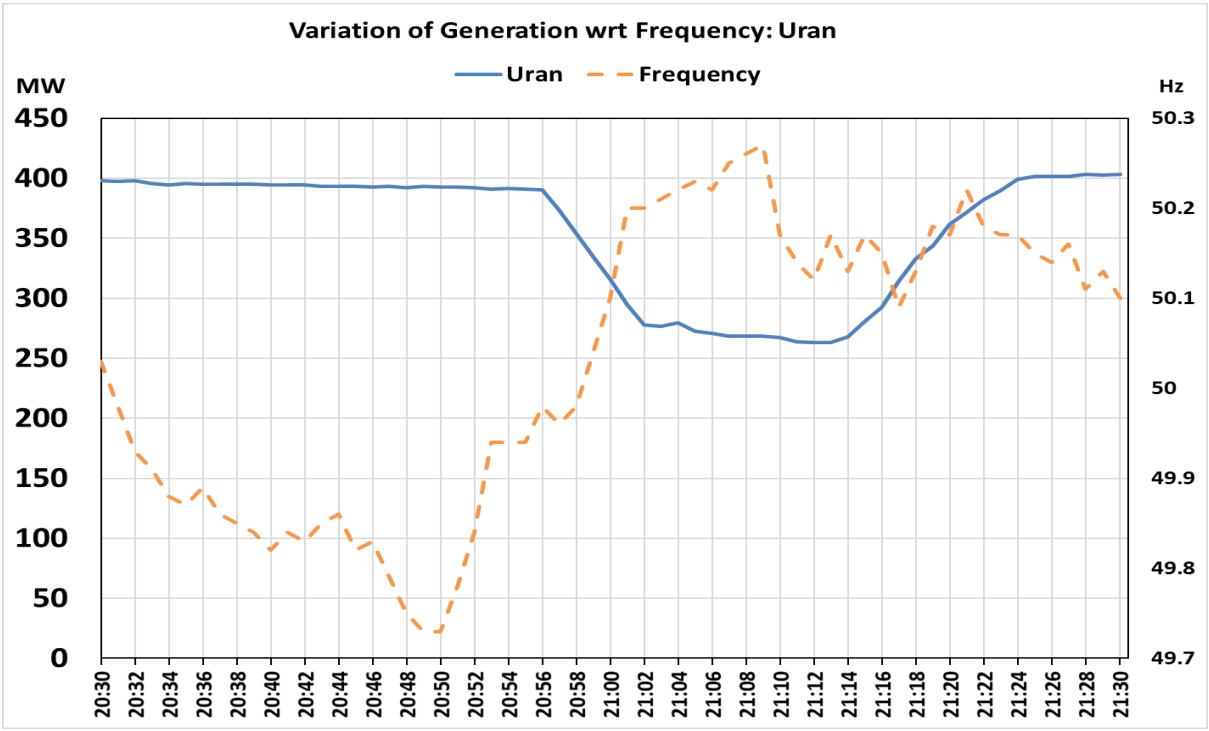
21:28
21:30


Variation of Generation wrt Frequency: Uran
Uran
Frequency
MW
Hz
450
400
350
300
250
200
150
100
50
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
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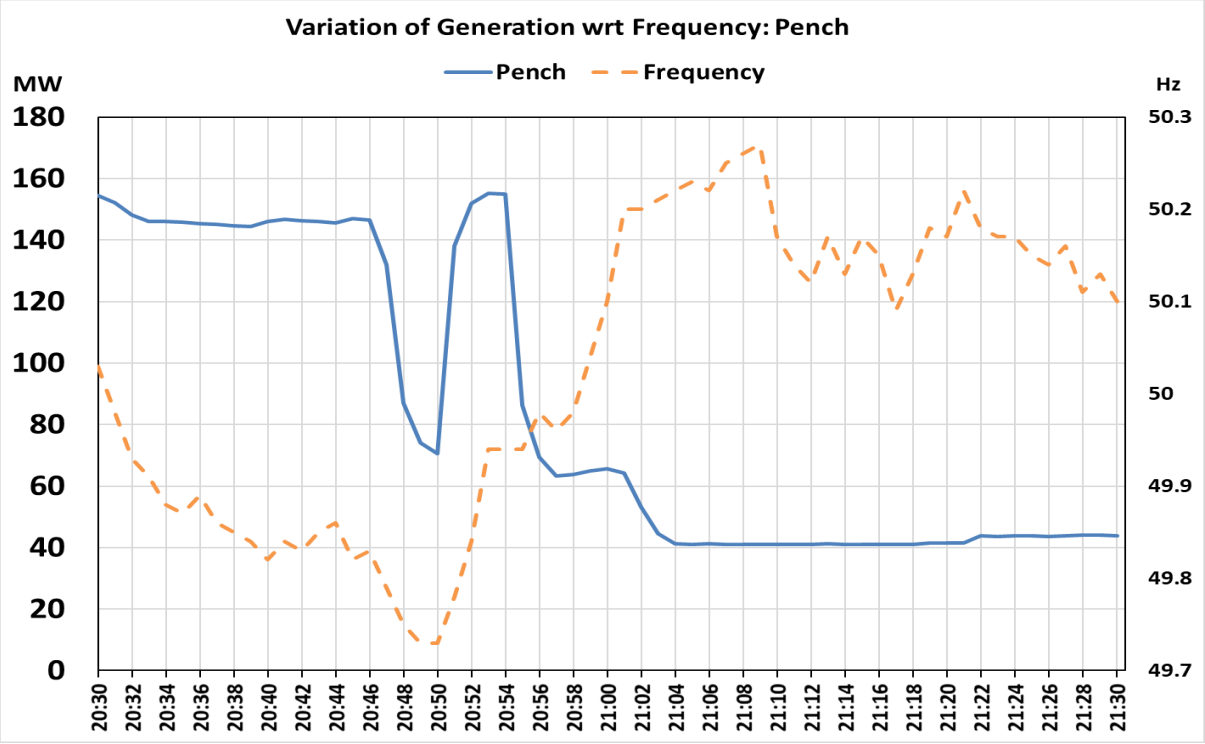
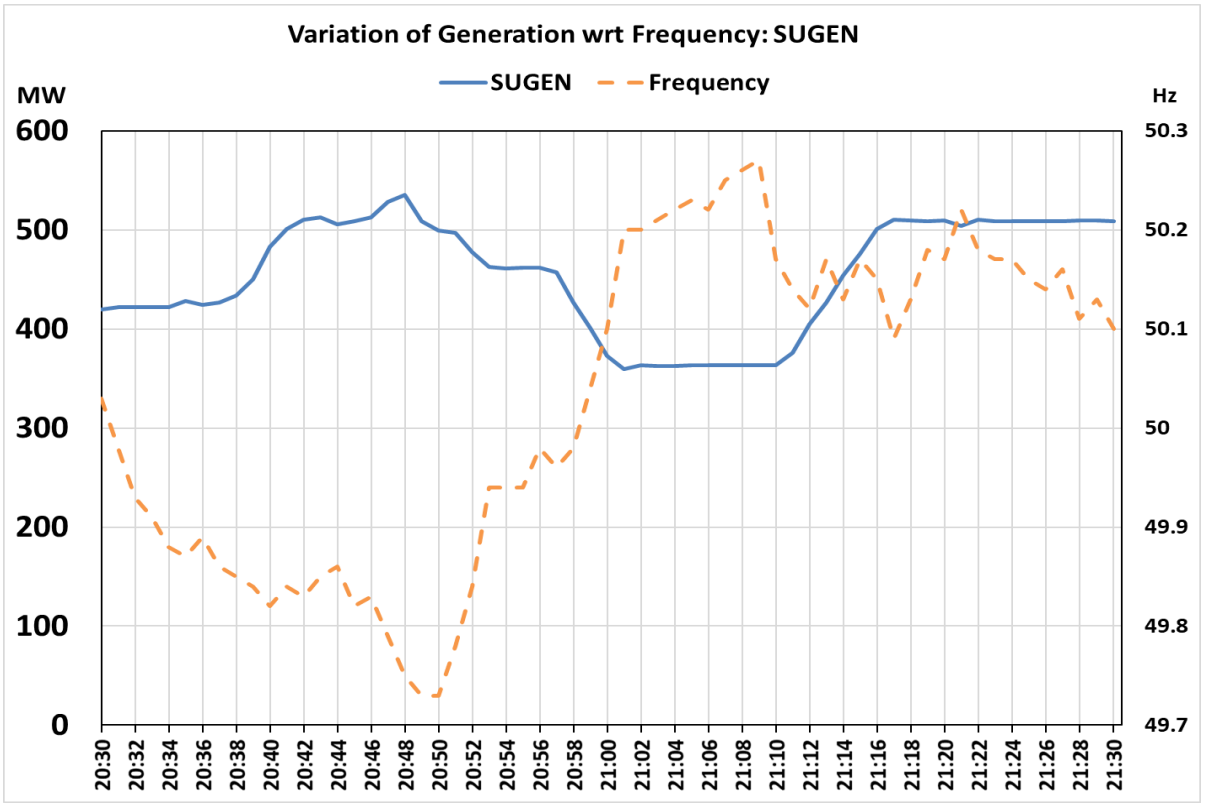
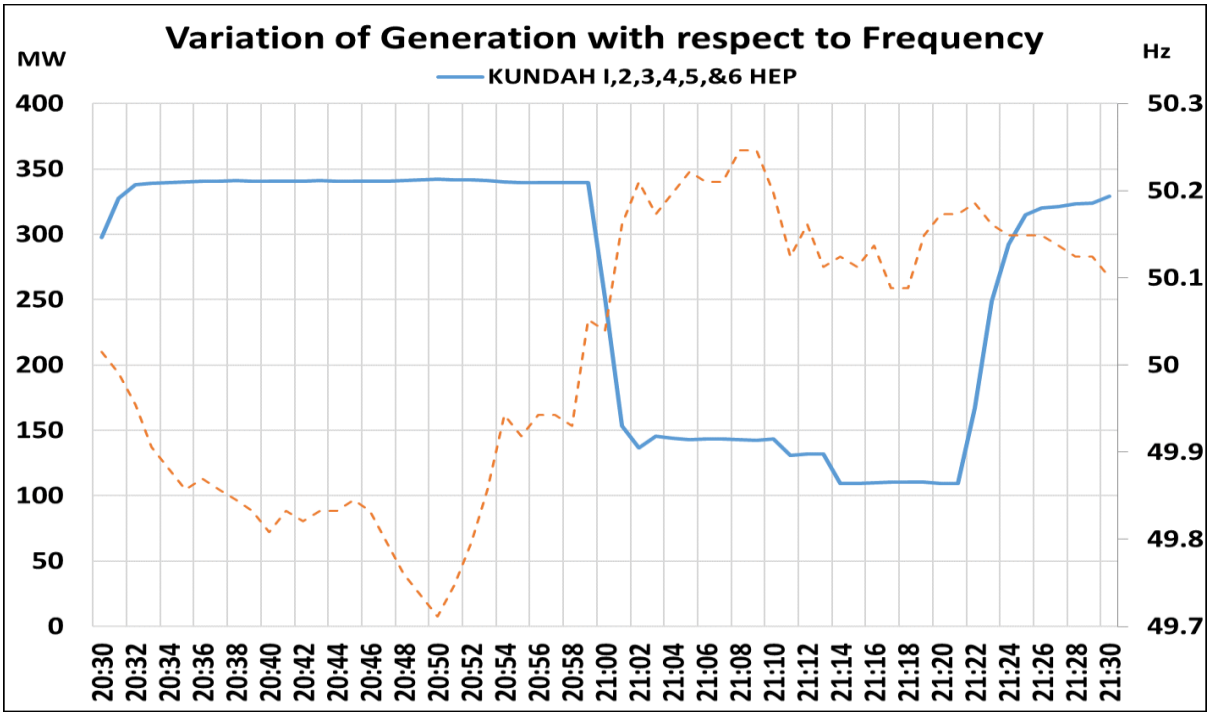
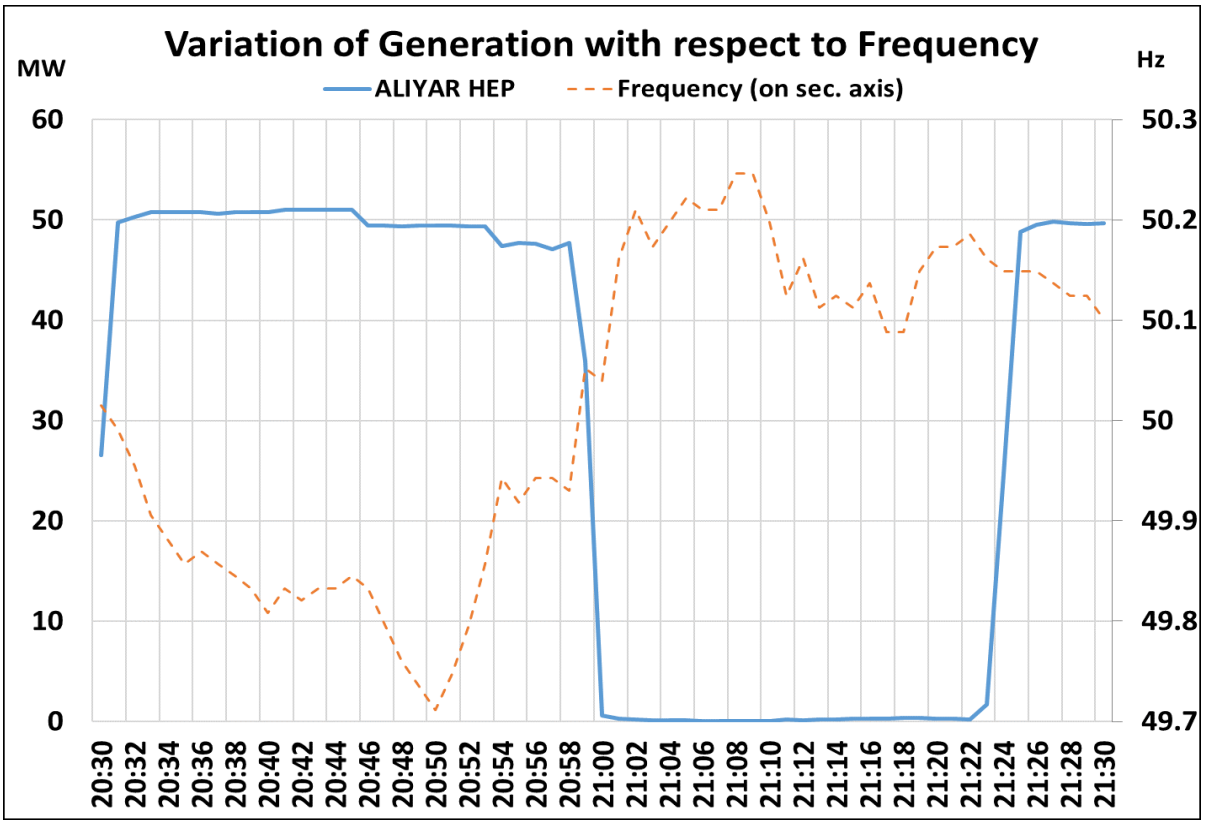
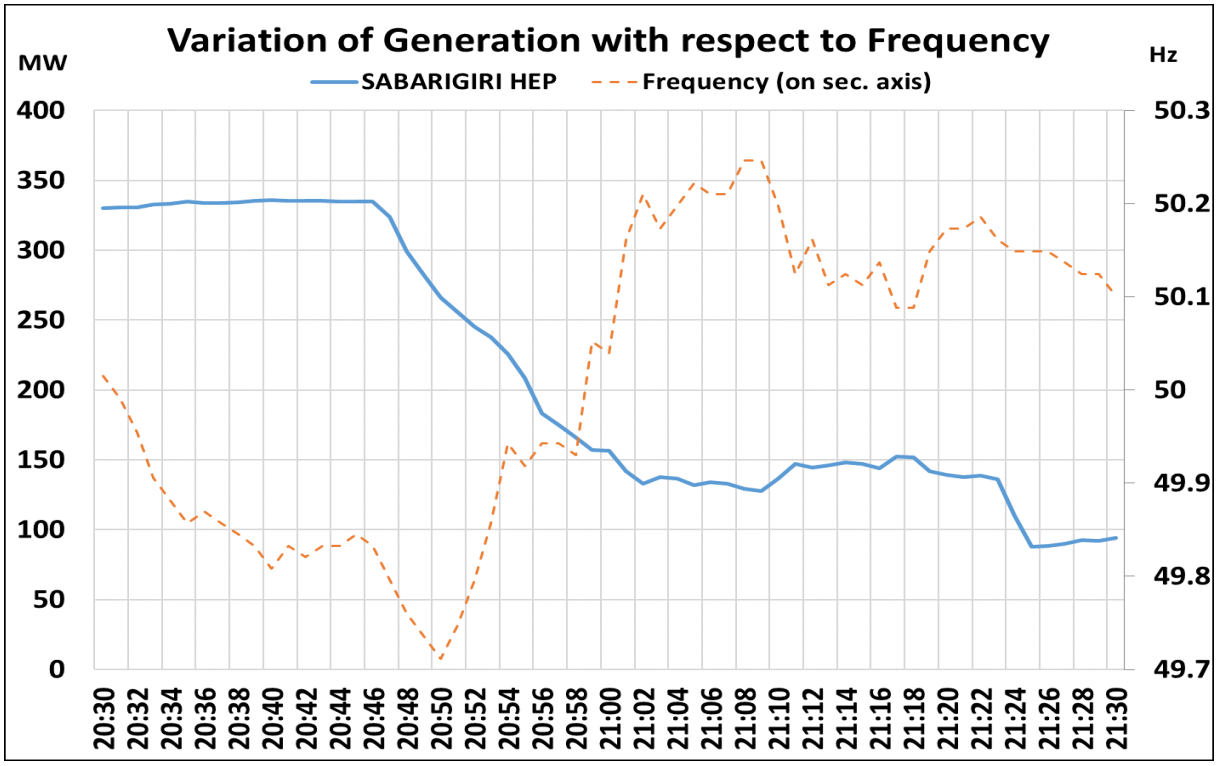
21:28
21:30

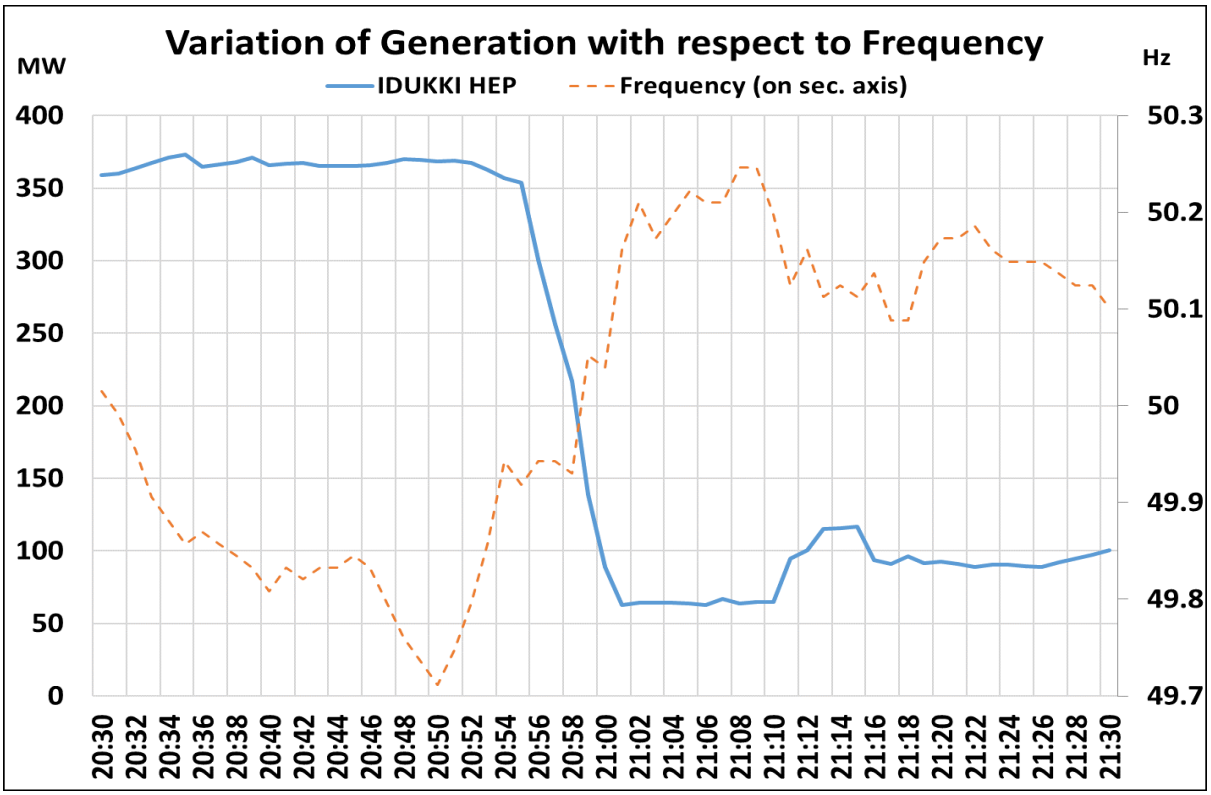

Variation of Generation wrt Frequency: Pench
Pench
Frequency
MW
Hz
180
160
140
120
100
80
60
40
20
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

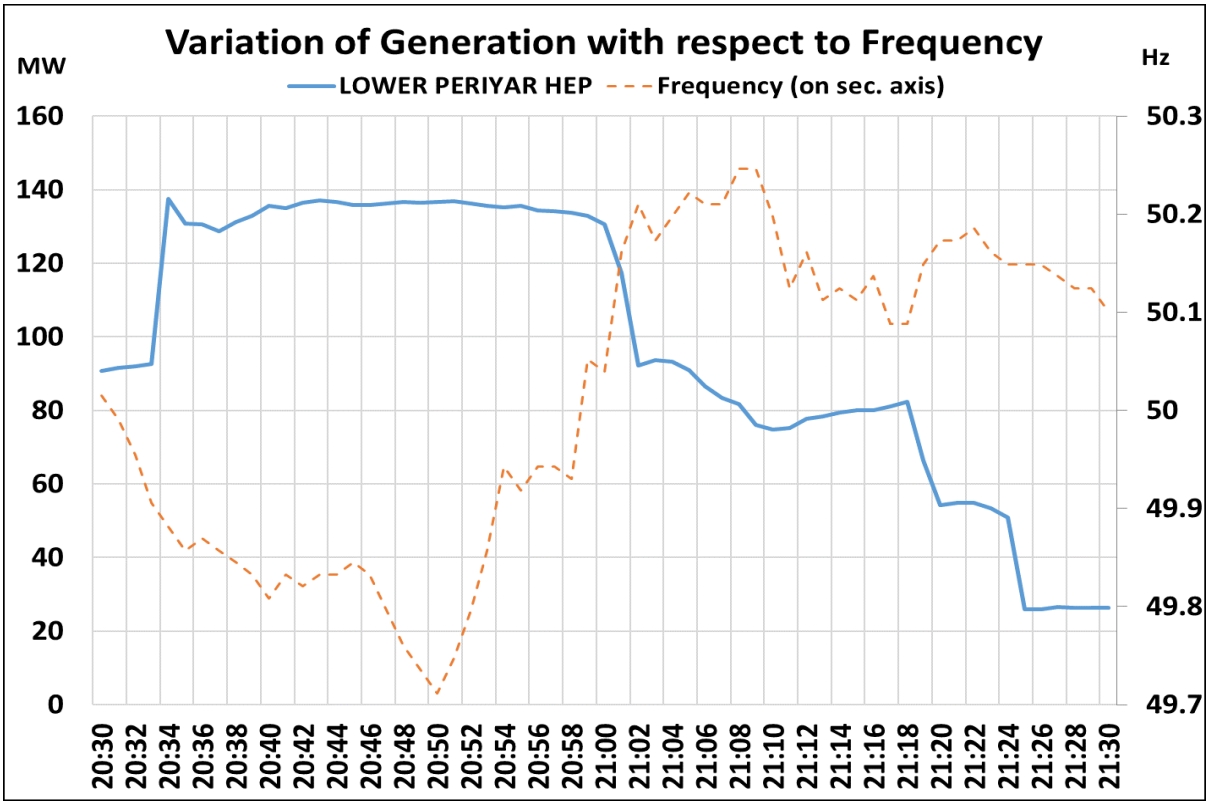

Variation of Generation wrt Frequency: SUGEN
SUGEN
Frequency
MW
Hz
600
500
400
300
200
100
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

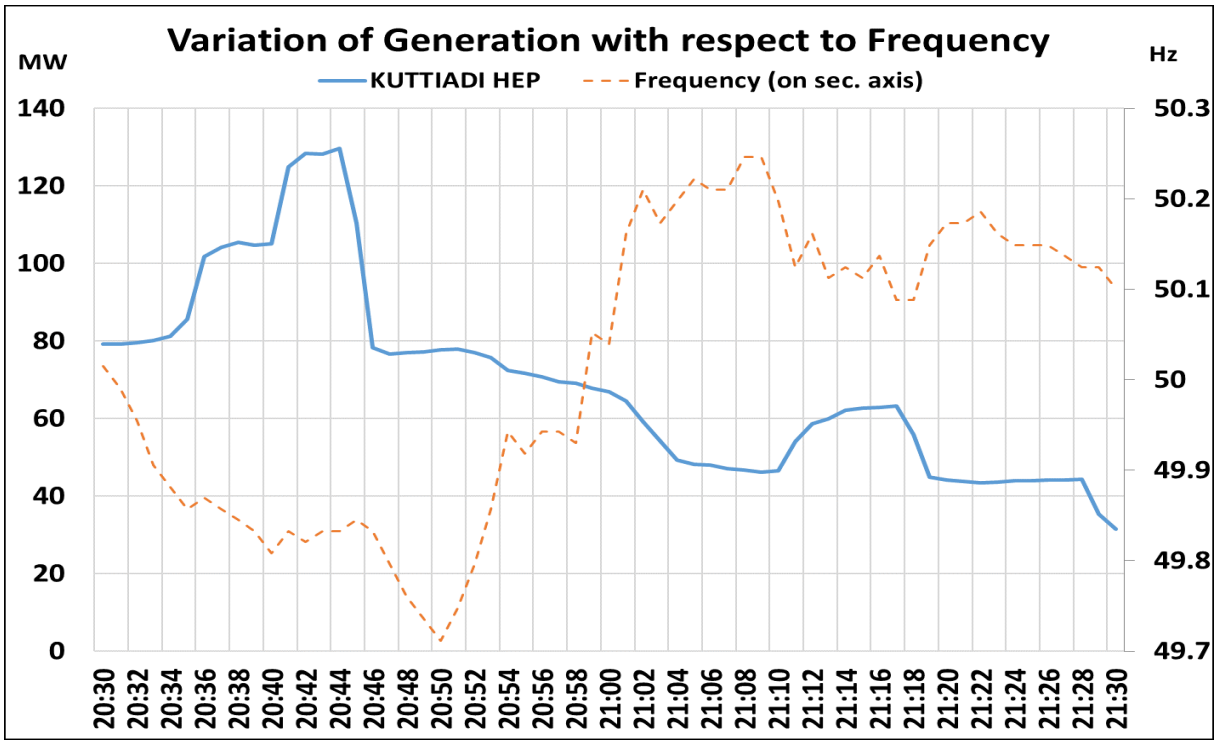

Variation of Generation with respect to Frequency
MW
Hz
KUNDAH I,2,3,4,5,&6 HEP
400
350
300
250
200
150
100
50
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

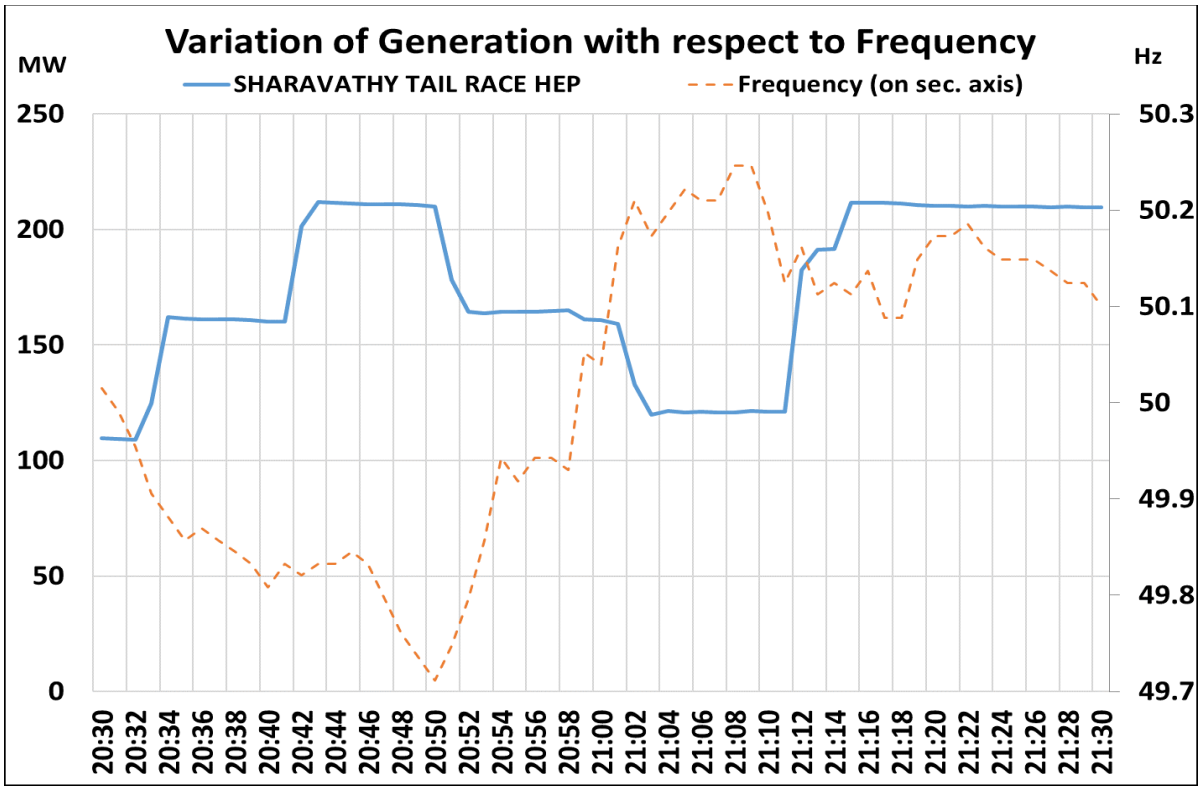

Variation of Generation with respect to Frequency
MW
Hz
ALIYAR HEP
Frequency (on sec. axis)
60
50
40
30
20
10
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

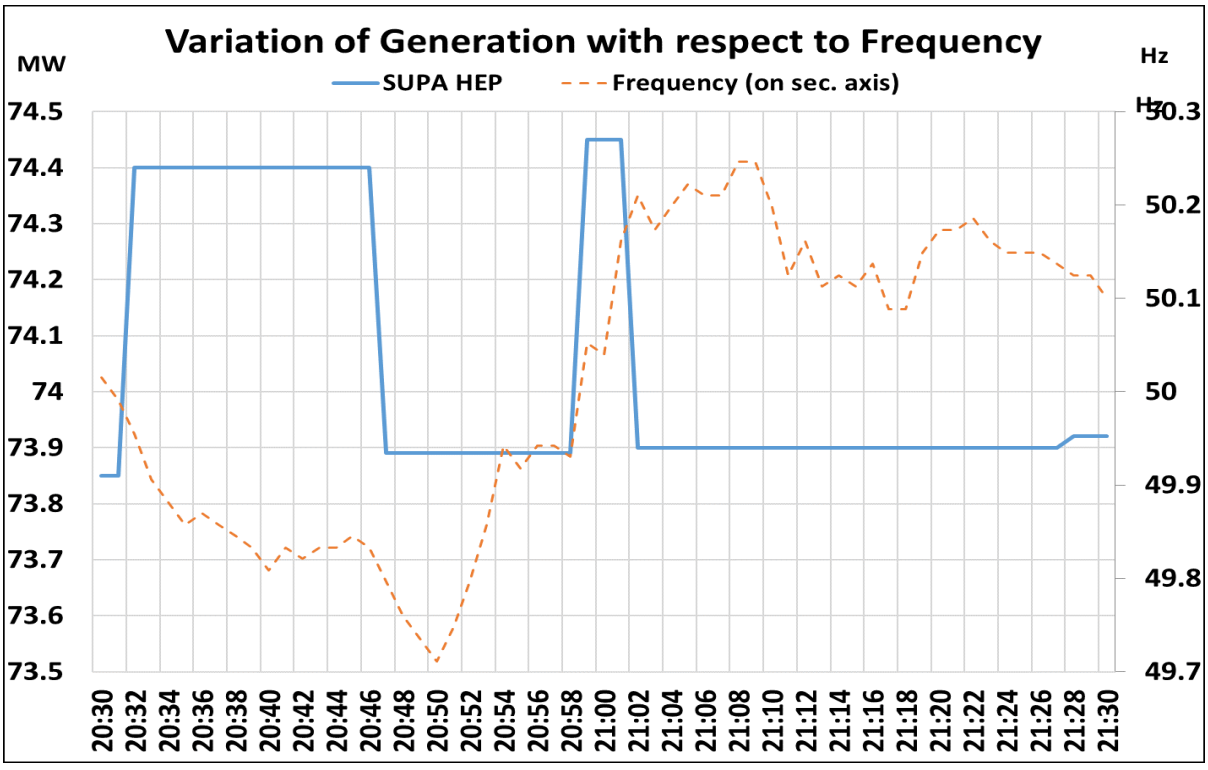

Variation of Generation with respect to Frequency
MW
Hz
SABARIGIRI HEP
Frequency (on sec. axis)
400
350
300
250
200
150
100
50
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

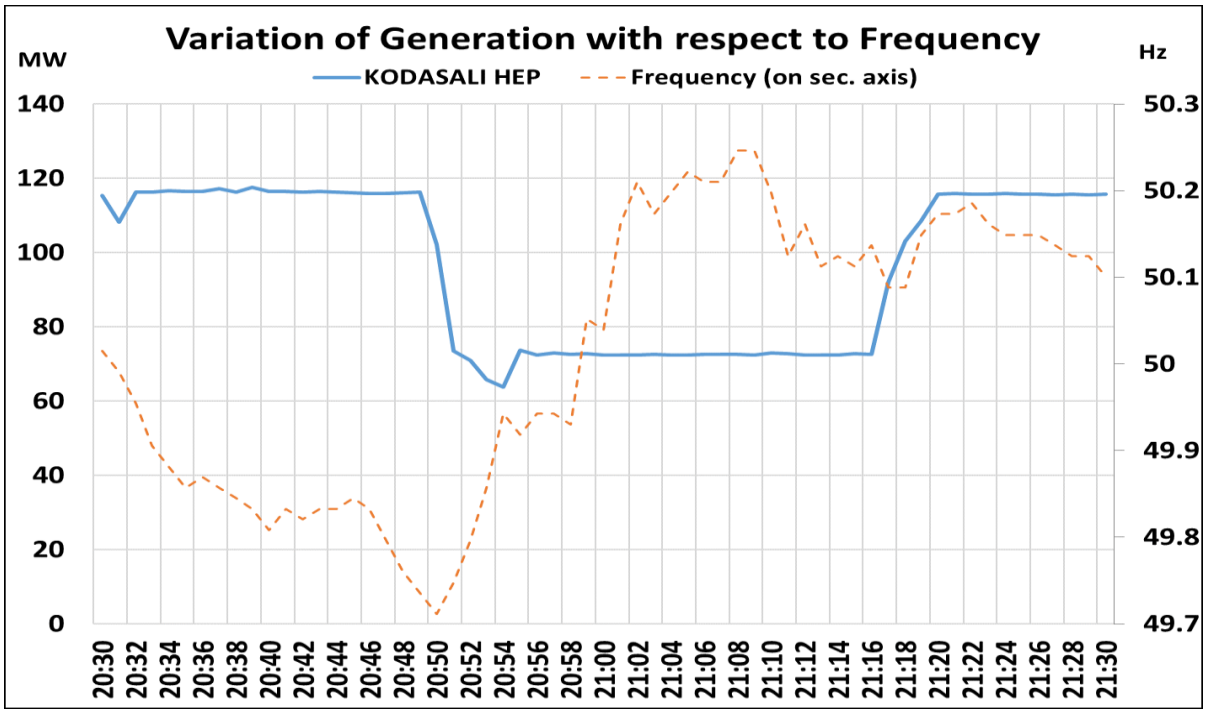

Variation of Generation with respect to Frequency
MW
Hz
IDUKKI HEP
Frequency (on sec. axis)
400
350
300
250
200
150
100
50
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

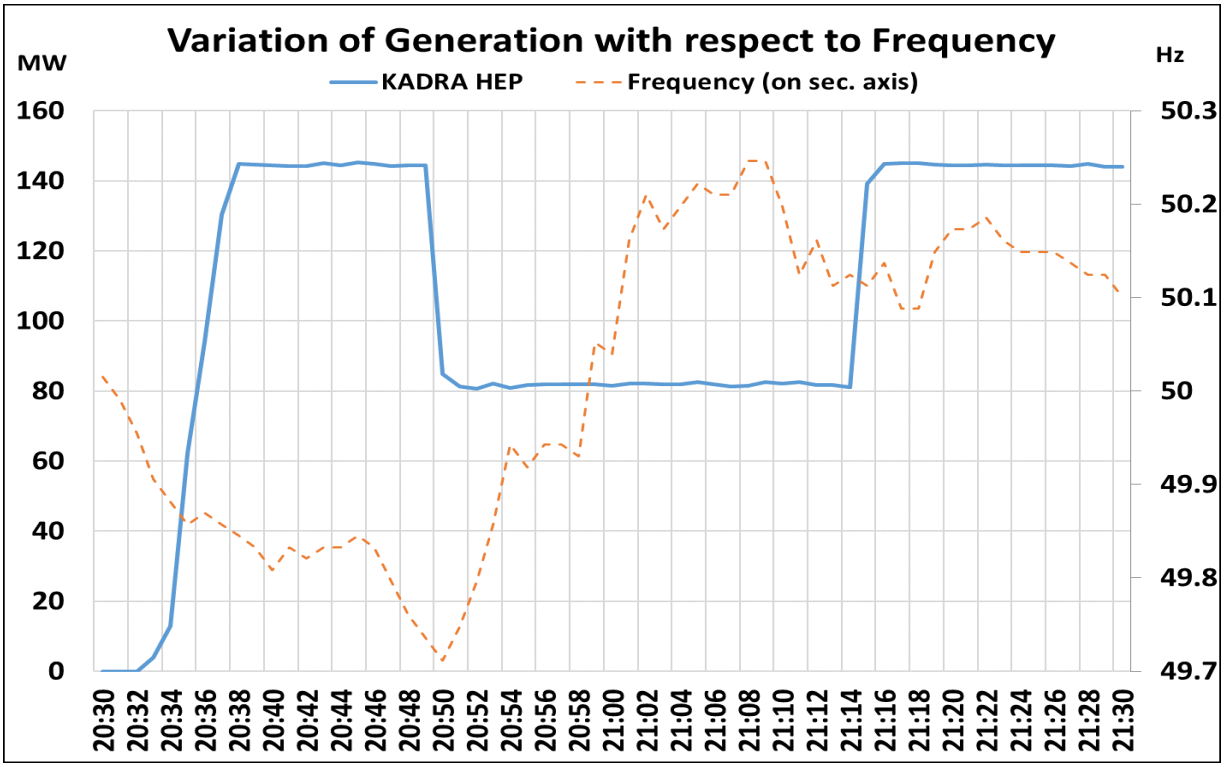

Variation of Generation with respect to Frequency
MW
Hz
LOWER PERIYAR HEP
Frequency (on sec. axis)
160
140
120
100
80
60
40
20
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

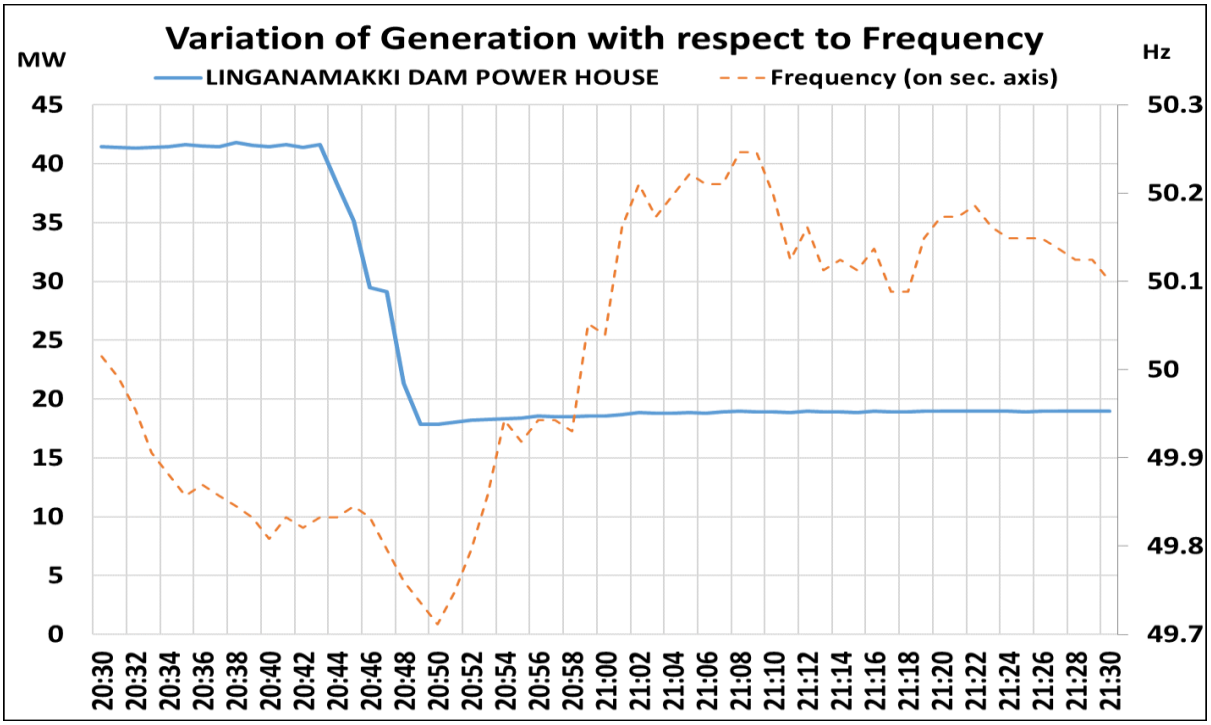

Variation of Generation with respect to Frequency
MW
Hz
KUTTIADI HEP
Frequency (on sec. axis)
140
120
100
80
60
40
20
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

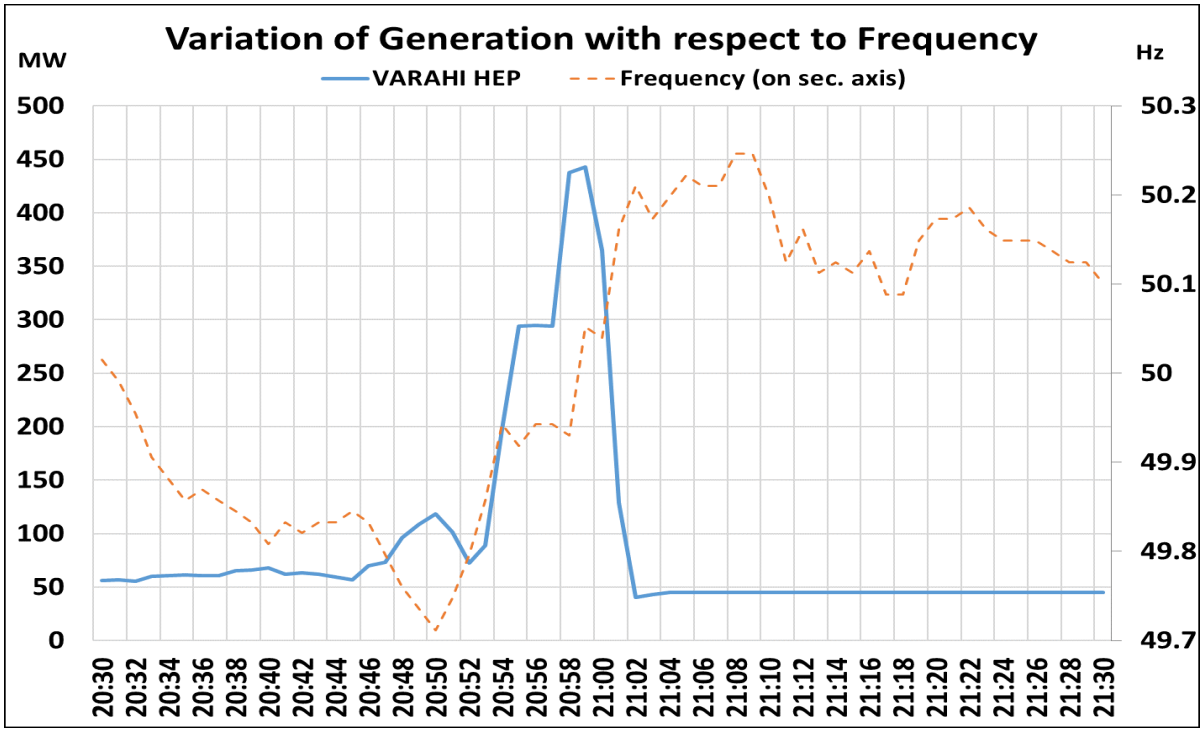

Variation of Generation with respect to Frequency
MW
Hz
SHARAVATHY TAIL RACE HEP
Frequency (on sec. axis)
250
200
150
100
50
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

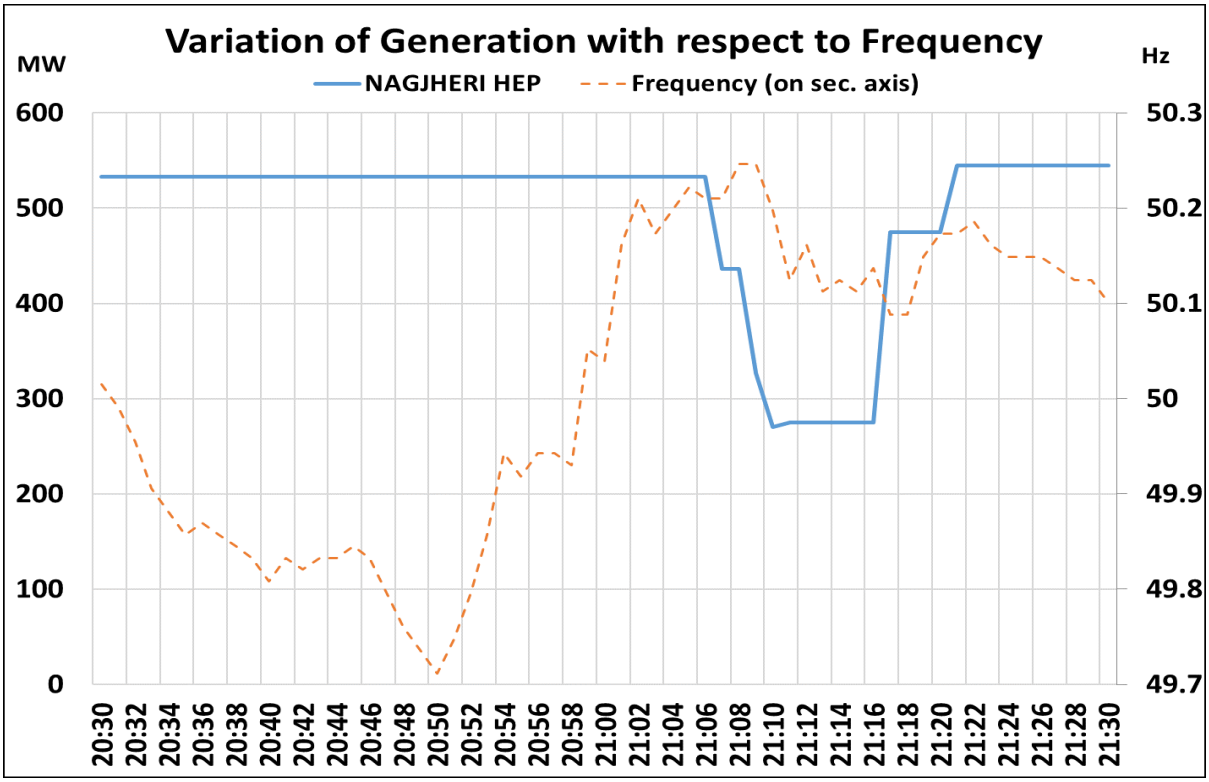

Variation of Generation with respect to Frequency
MW
Hz
SUPA HEP
Frequency (on sec. axis)
74.5
74.4
74.3
74.2
74.1
74
73.9
73.8
73.7
73.6
73.5
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

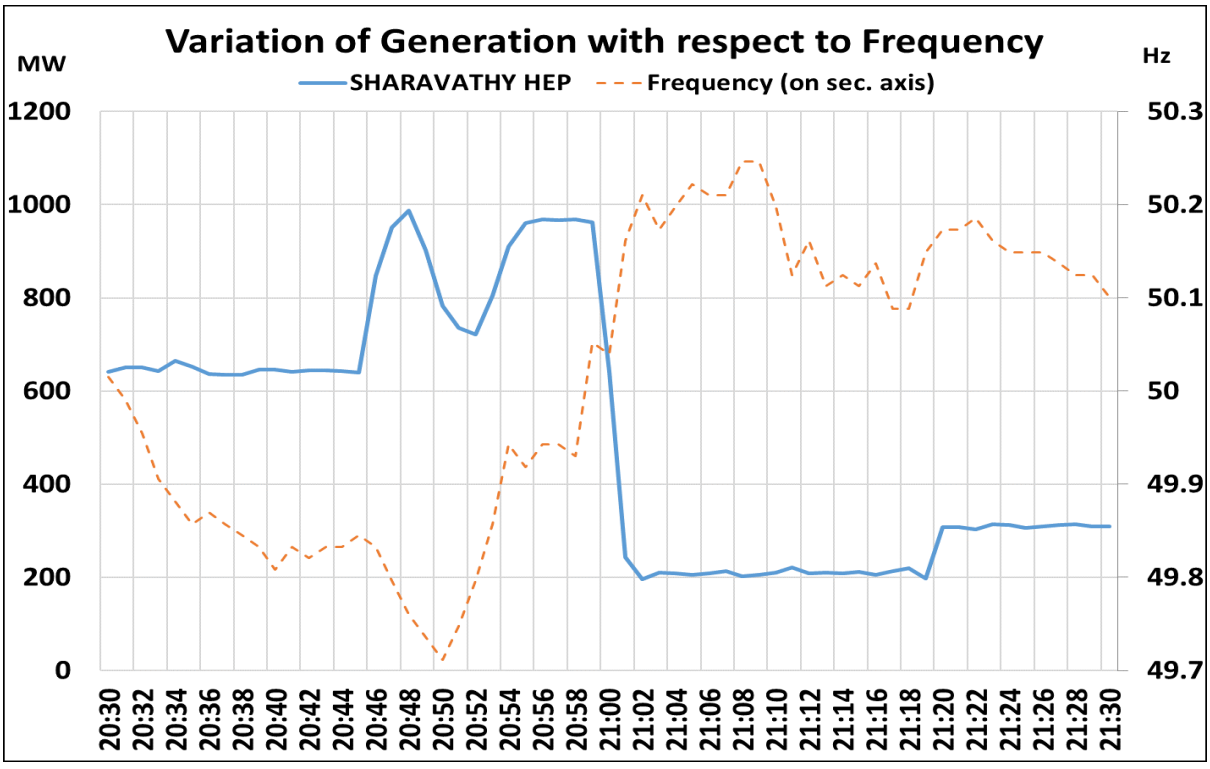

Variation of Generation with respect to Frequency
MW
Hz
KODASALI HEP
Frequency (on sec. axis)
140
120
100
80
60
40
20
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

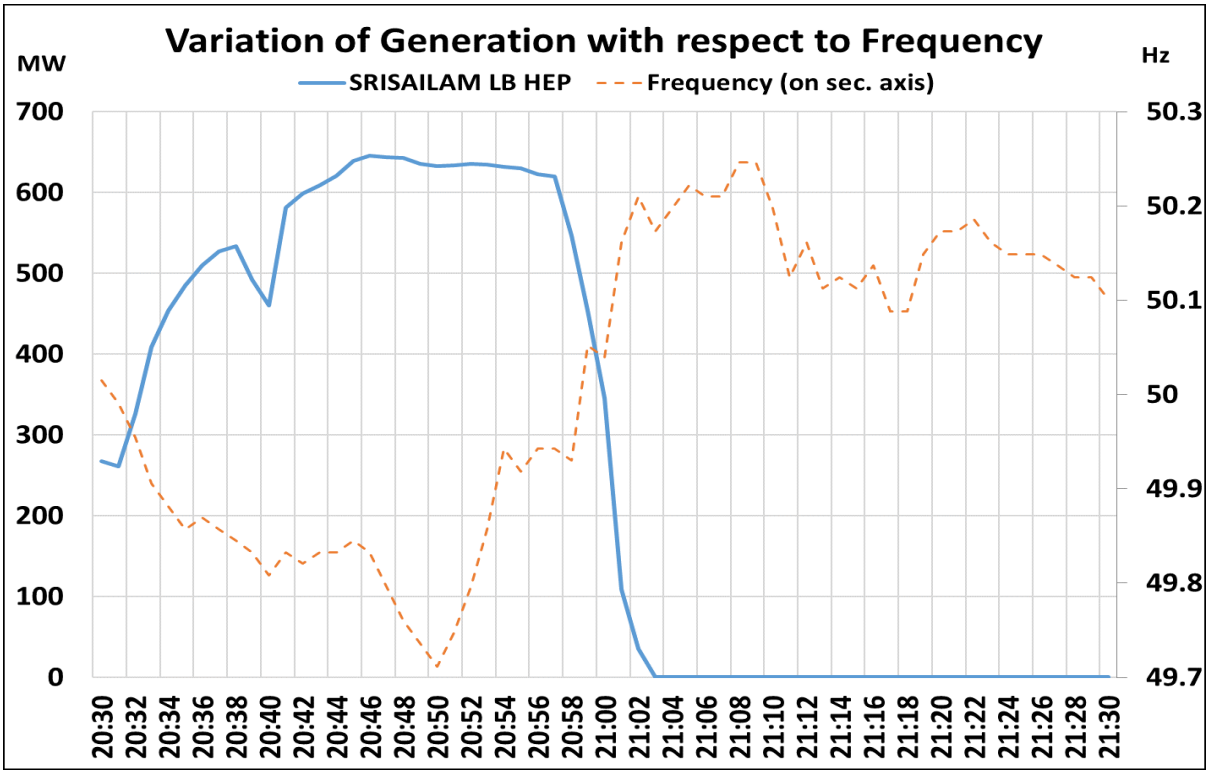

Variation of Generation with respect to Frequency
MW
Hz
KADRA HEP
Frequency (on sec. axis)
160
140
120
100
80
60
40
20
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

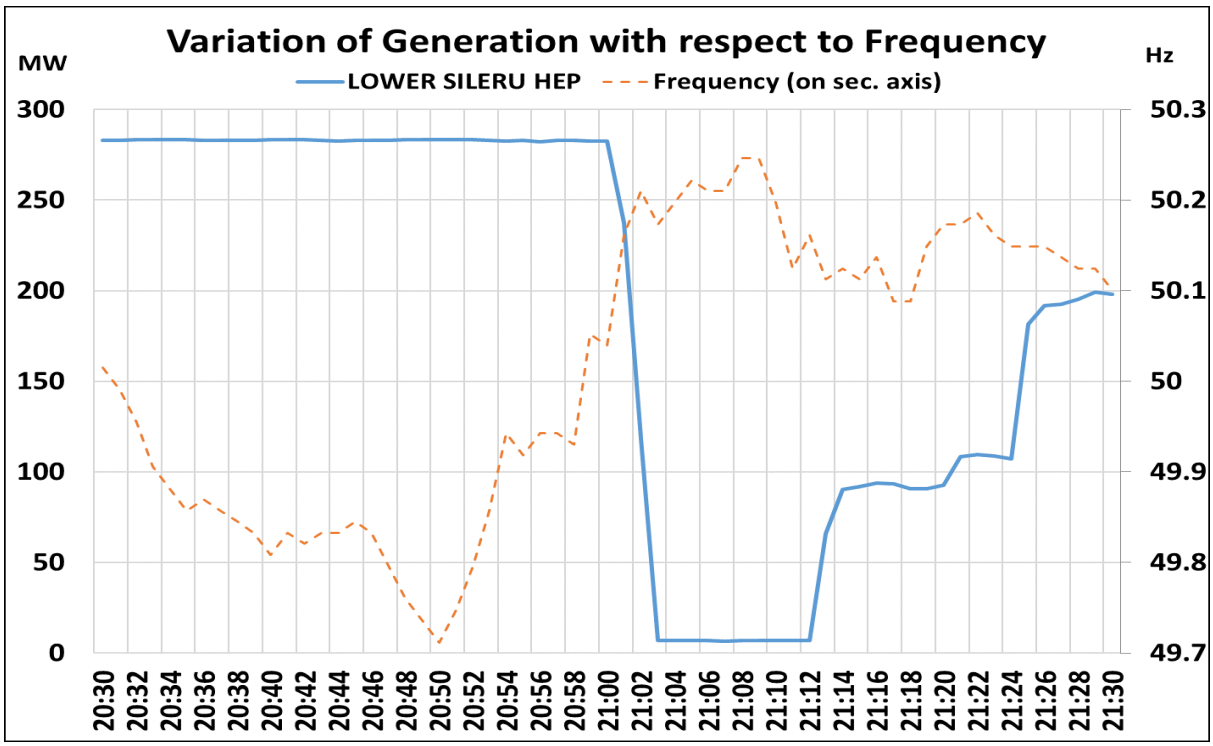

Variation of Generation with respect to Frequency
MW
Hz
LINGANAMAKKI DAM POWER HOUSE
Frequency (on sec. axis)
45
40
35
30
25
20
15
10
5
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

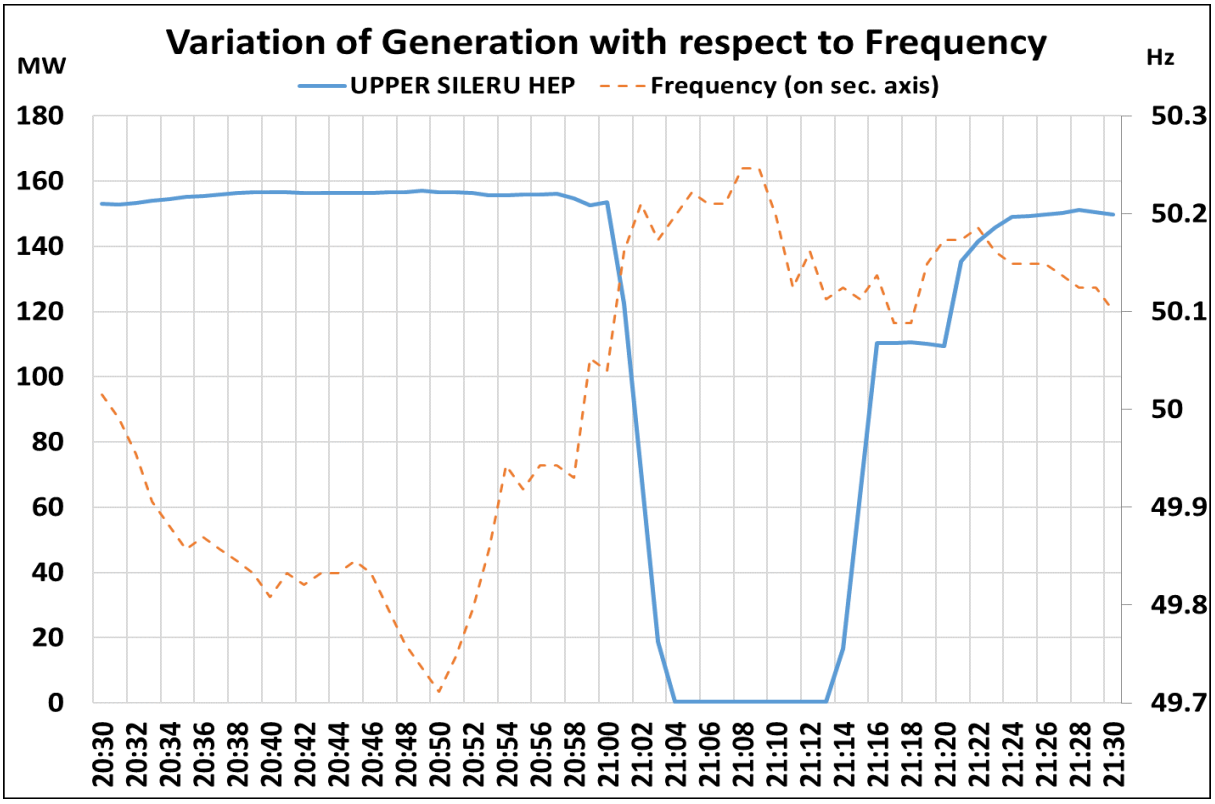

Variation of Generation with respect to Frequency
MW
Hz
VARAHI HEP
Frequency (on sec. axis)
500
450
400
350
300
250
200
150
100
50
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

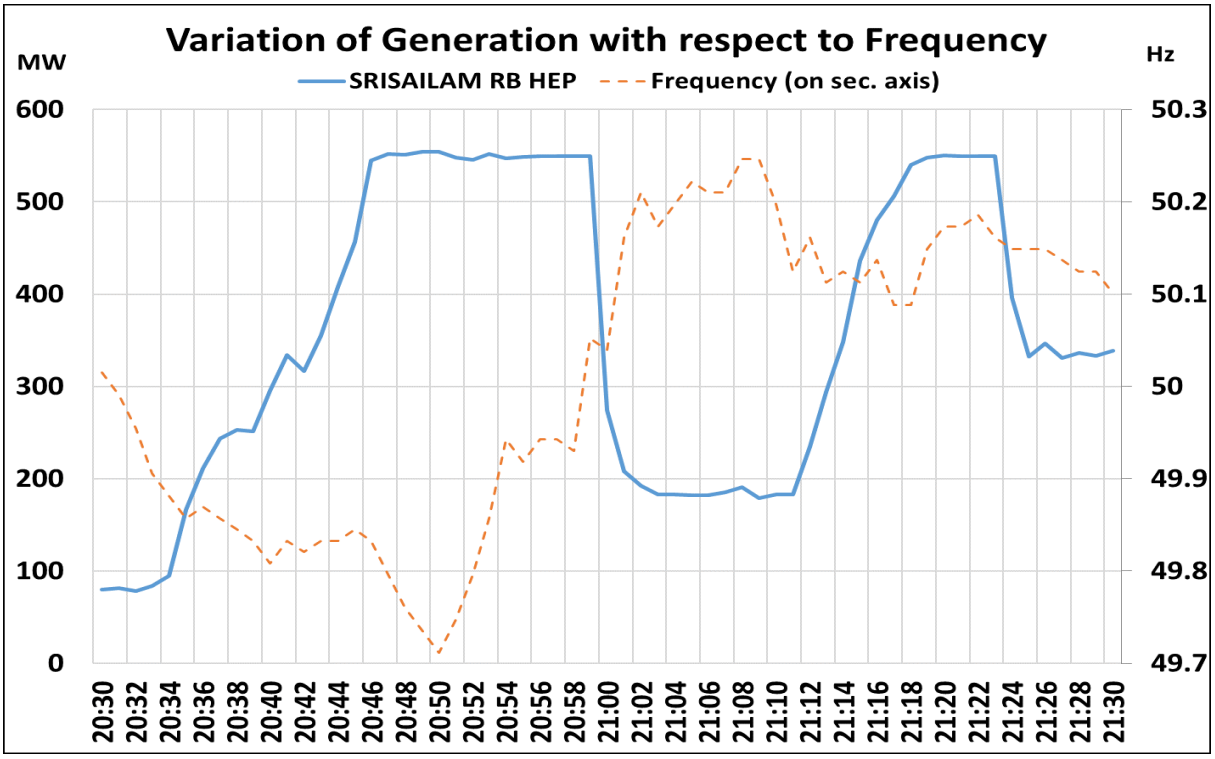

Variation of Generation with respect to Frequency
MW
Hz
NAGJHERI HEP
Frequency (on sec. axis)
600
500
400
300
200
100
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
MW
Hz
SHARAVATHY HEP
Frequency (on sec. axis)
1200
1000
800
600
400
200
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

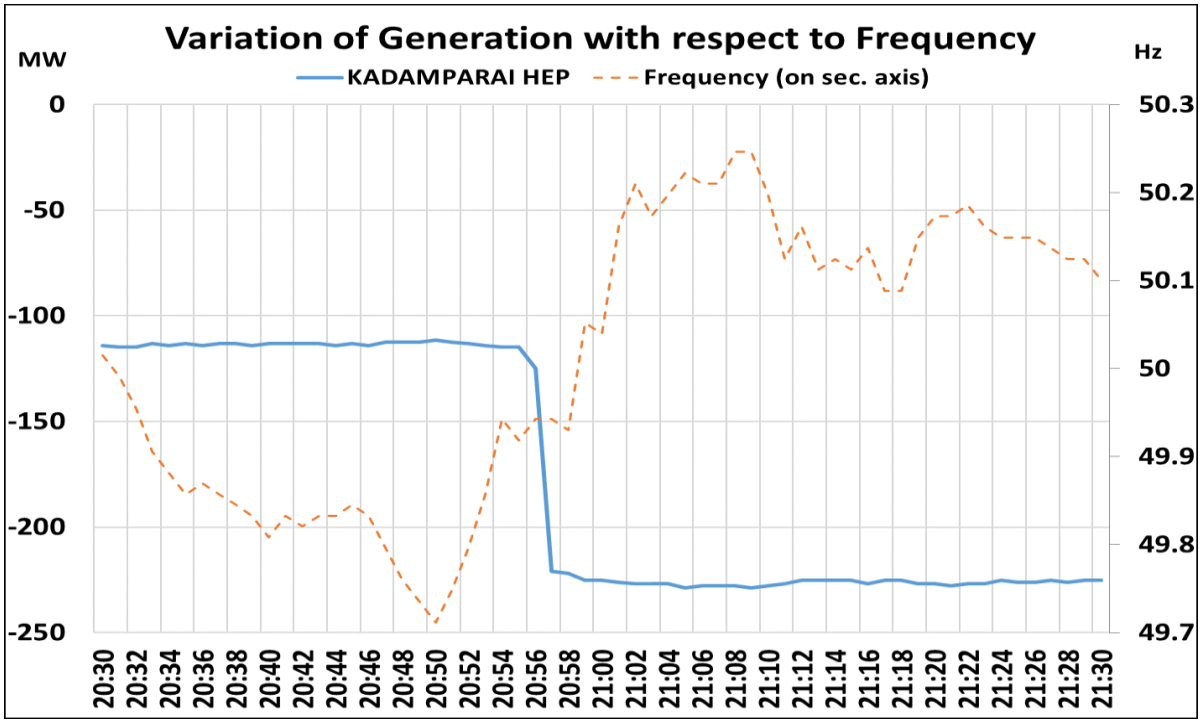

Variation of Generation with respect to Frequency
MW
Hz
SRISAILAM LB HEP
Frequency (on sec. axis)
700
600
500
400
300
200
100
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

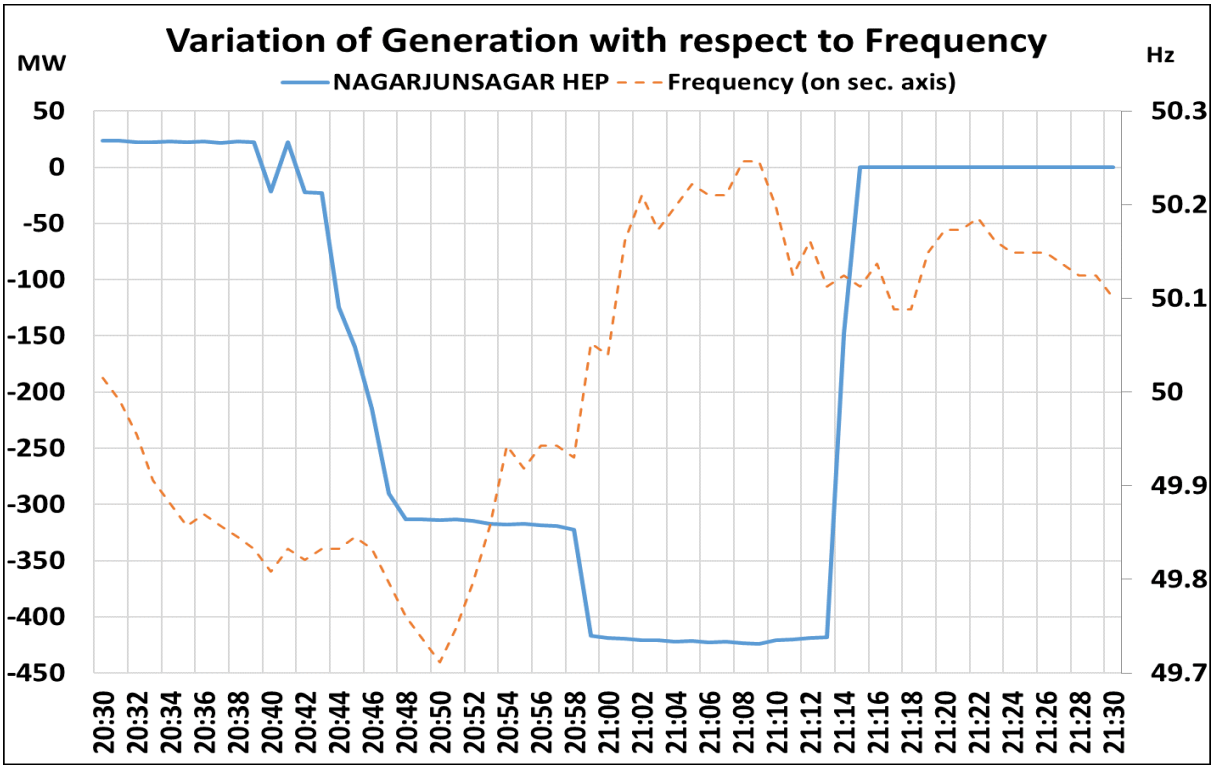

Variation of Generation with respect to Frequency
MW
Hz
LOWER SILERU HEP
Frequency (on sec. axis)
300
250
200
150
100
50
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30





Pump storage plants


Variation of Generation with respect to Frequency
MW
Hz
KADAMPARAI HEP
Frequency (on sec. axis)
0
-50
-100
-150
-200
-250
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
MW
Hz
NAGARJUNSAGAR HEP
Frequency (on sec. axis)
50
0
-50
-100
-150
-200
-250
-300
-350
-400
-450
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
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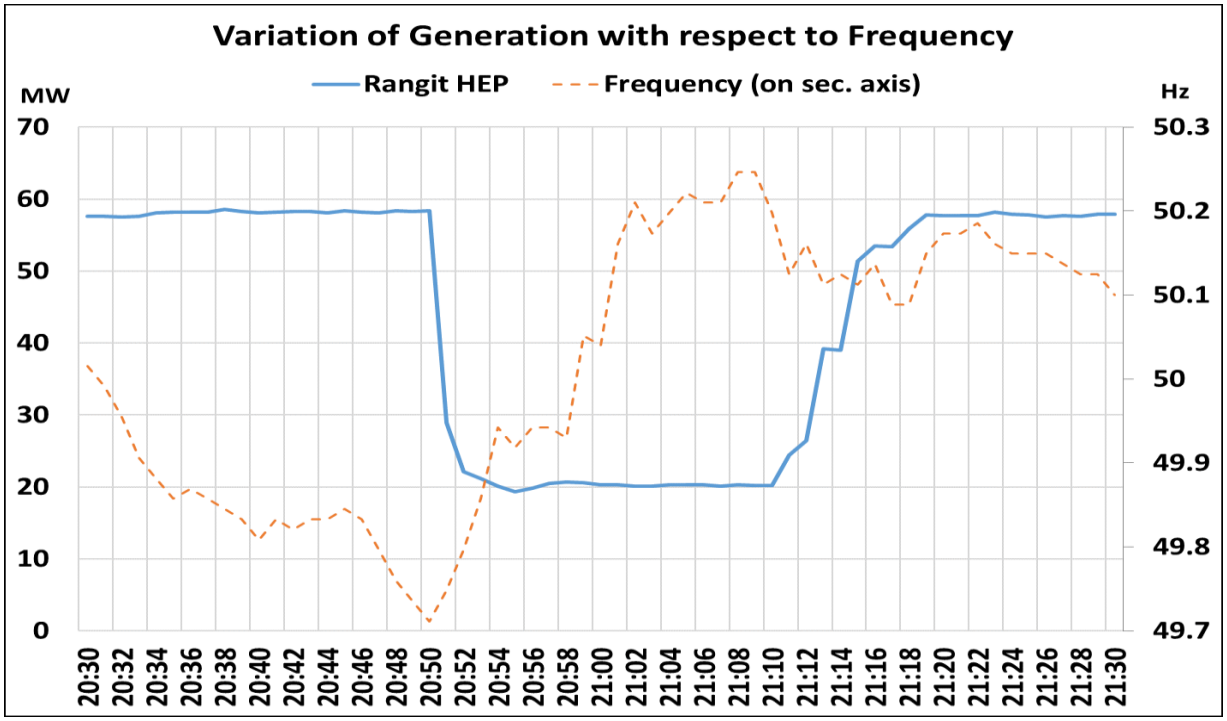
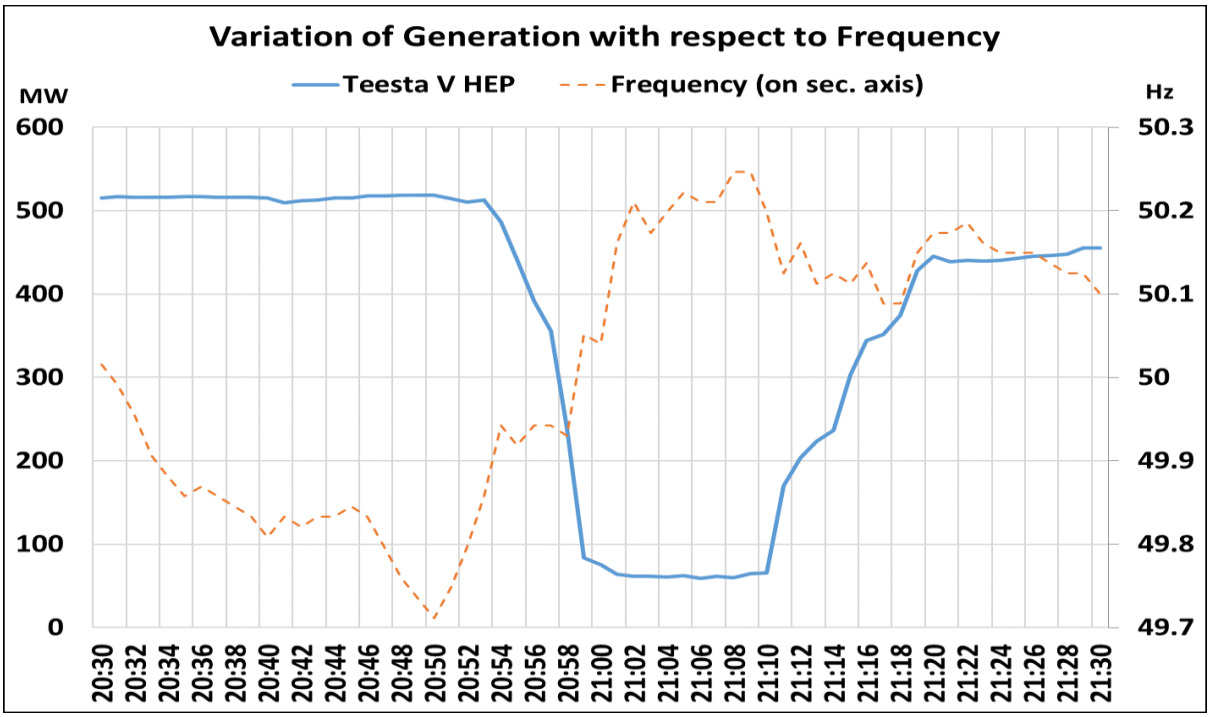
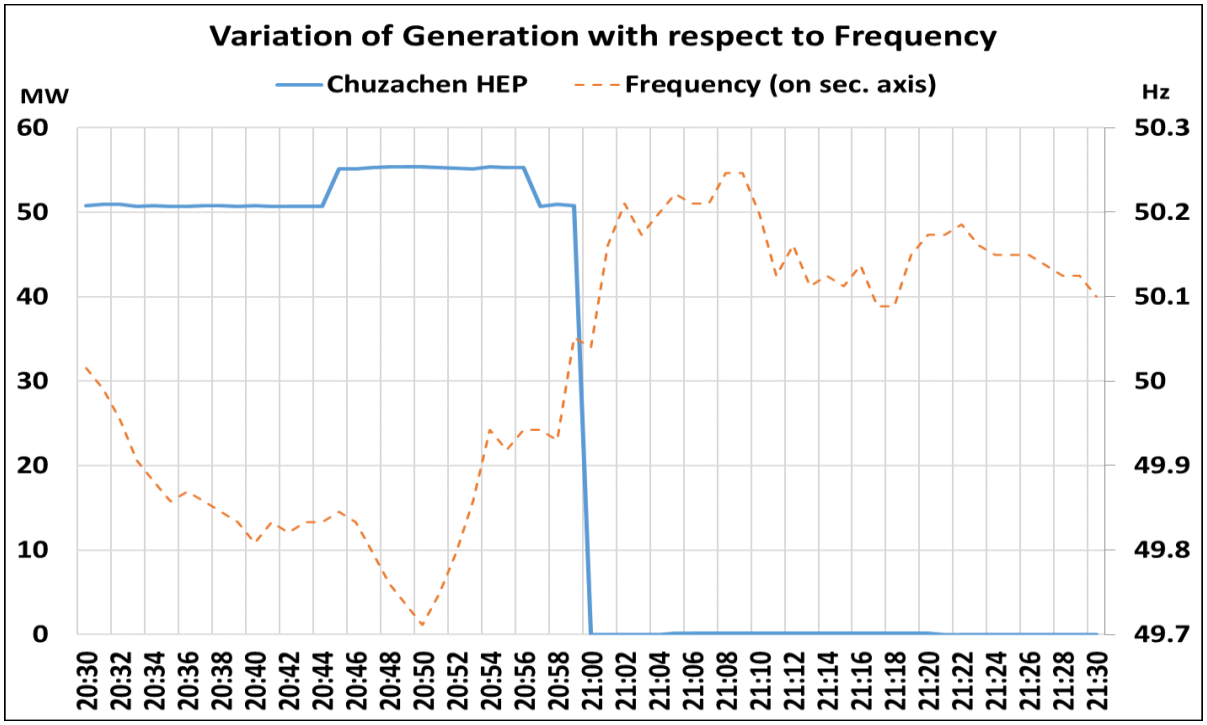
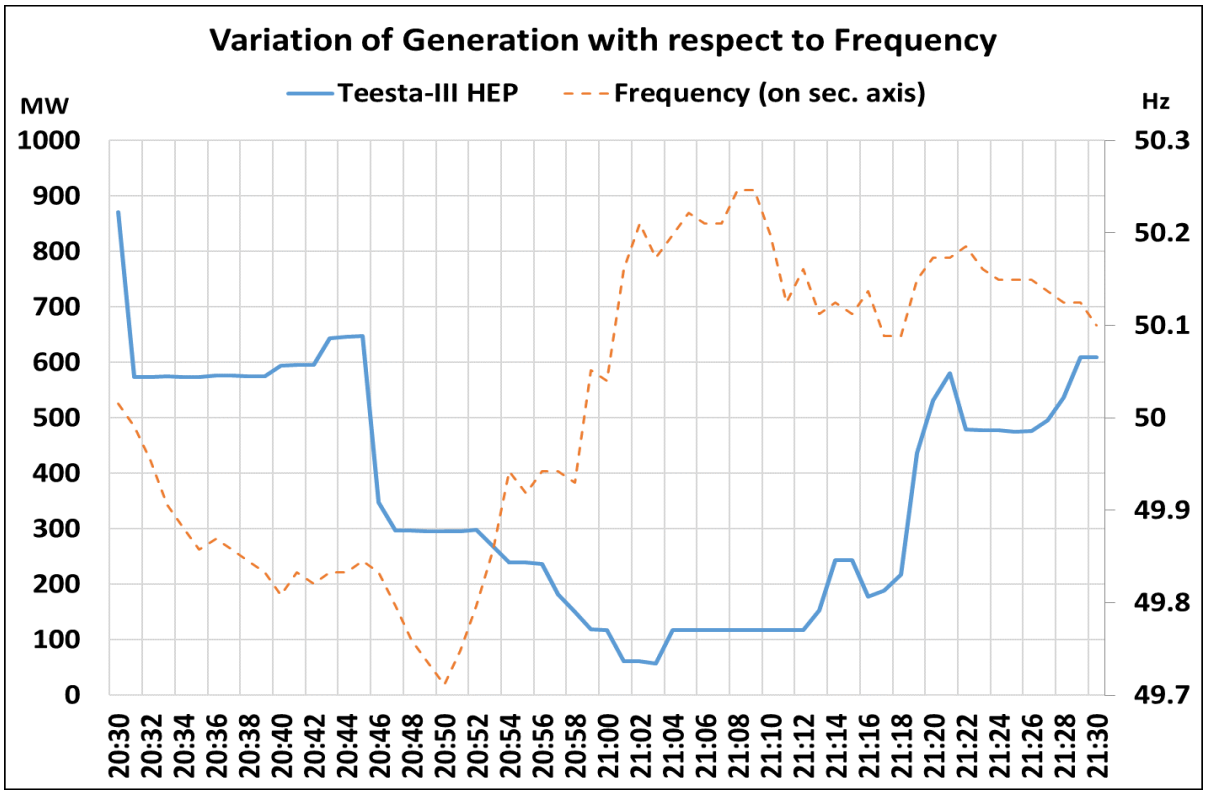
Eastern Region






Variation of Generation with respect to Frequency
Chuzachen HEP
Frequency (on sec. axis)
MW
Hz
60
50
40
30
20
10
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Teesta-III HEP
Frequency (on sec. axis)
MW
Hz
1000
900
800
700
600
500
400
300
200
100
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
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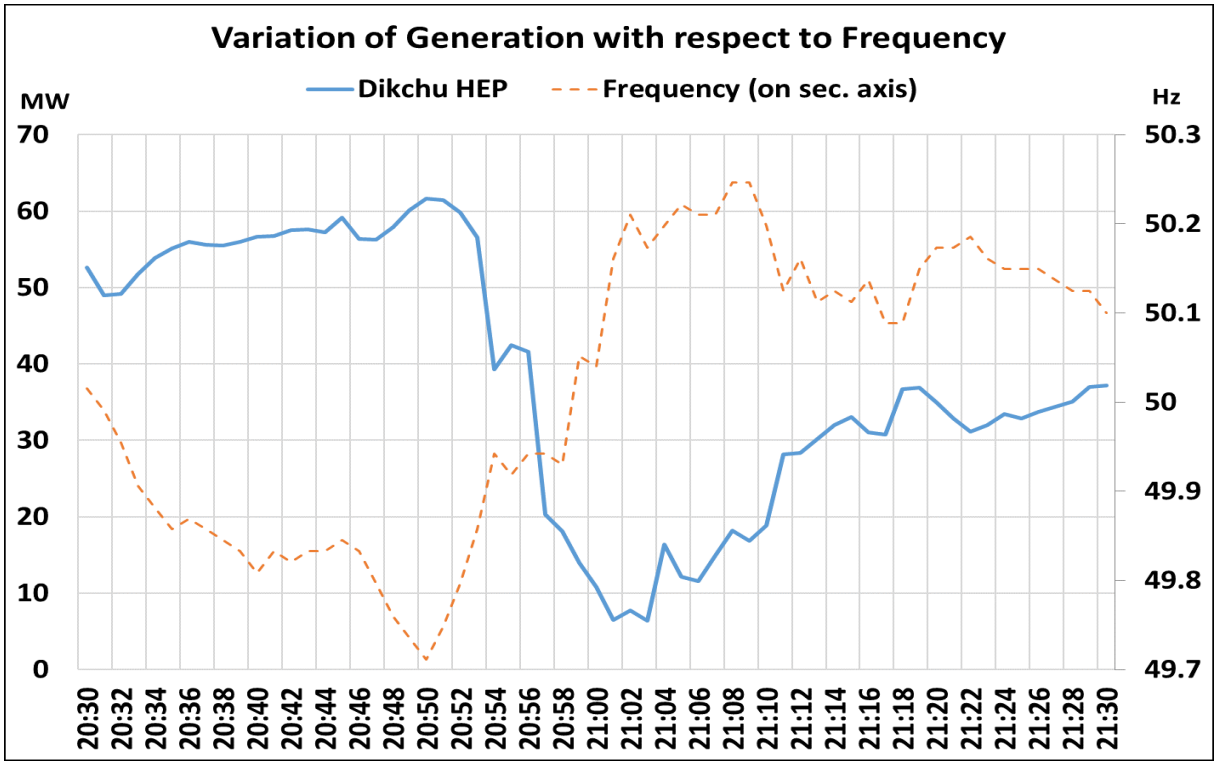
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Dikchu HEP
Frequency (on sec. axis)
MW
Hz
70
60
50
40
30
20
10
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
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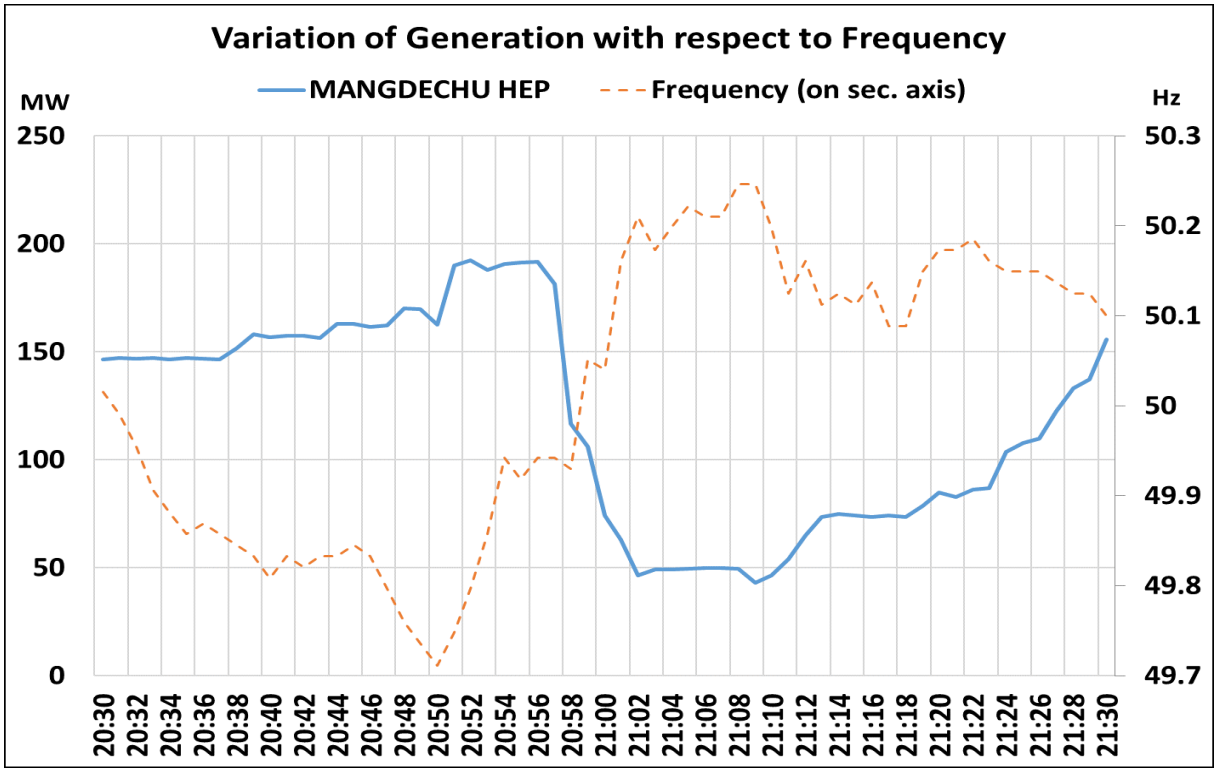
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
MANGDECHU HEP
Frequency (on sec. axis)
MW
Hz
250
200
150
100
50
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
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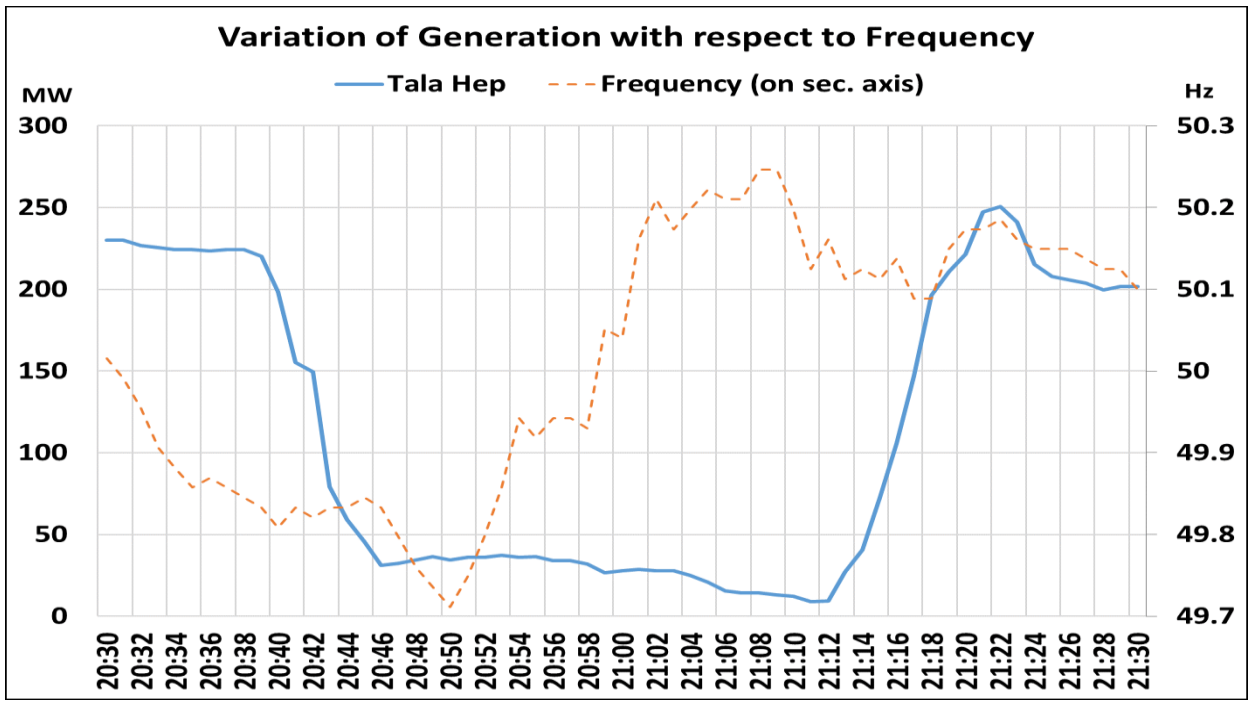
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Tala Hep
Frequency (on sec. axis)
MW
Hz
300
250
200
150
100
50
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
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21:06
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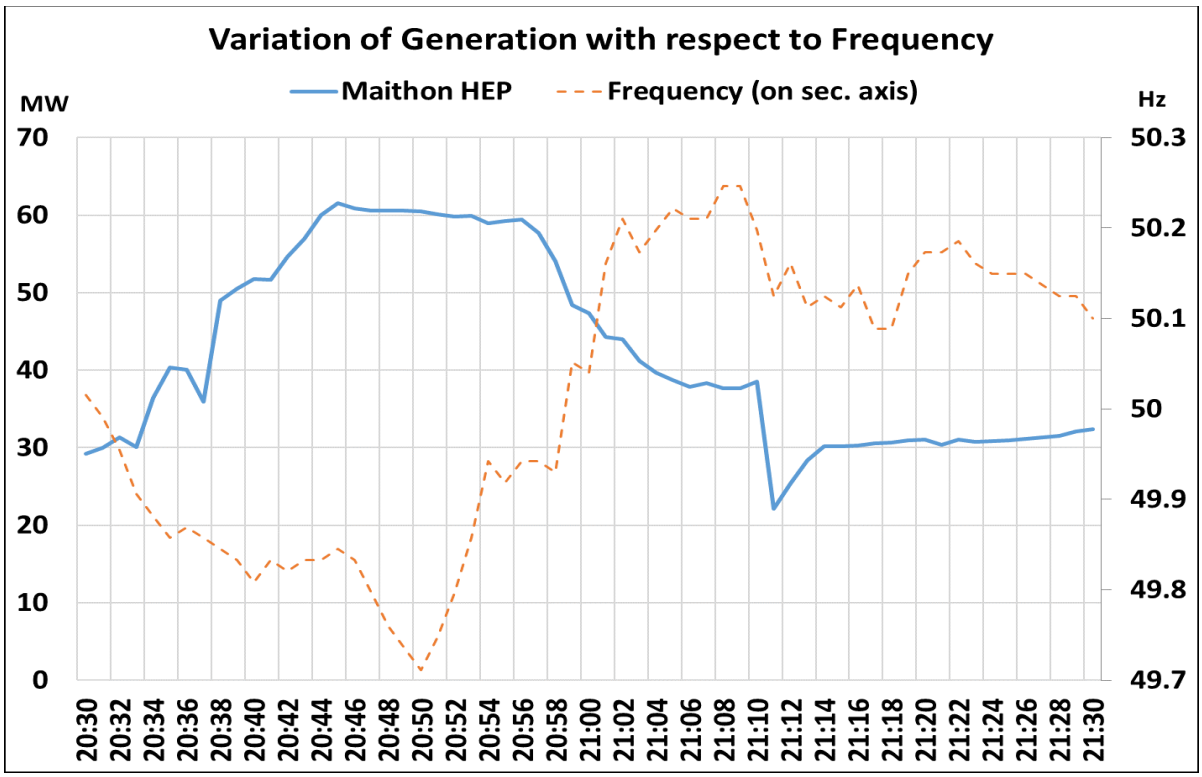
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Maithon HEP
Frequency (on sec. axis)
MW
Hz
70
60
50
40
30
20
10
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
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21:22
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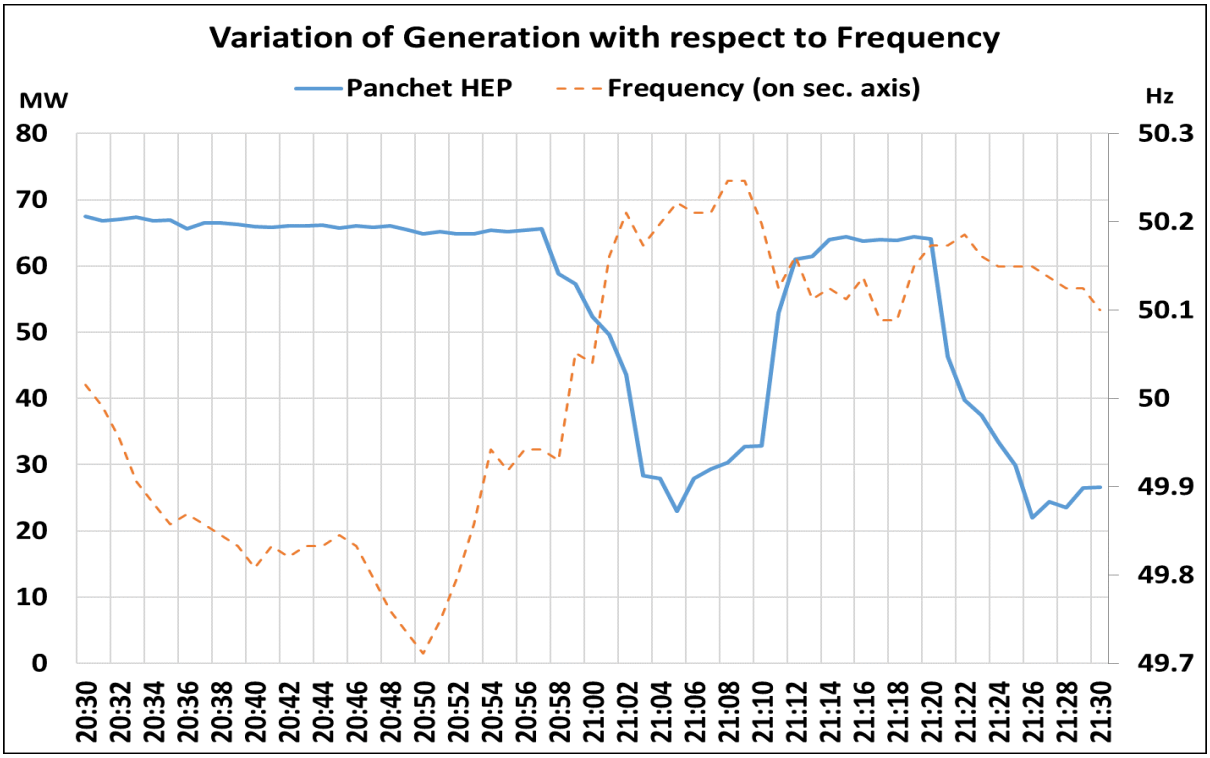
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Panchet HEP
Frequency (on sec. axis)
MW
Hz
80
70
60
50
40
30
20
10
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
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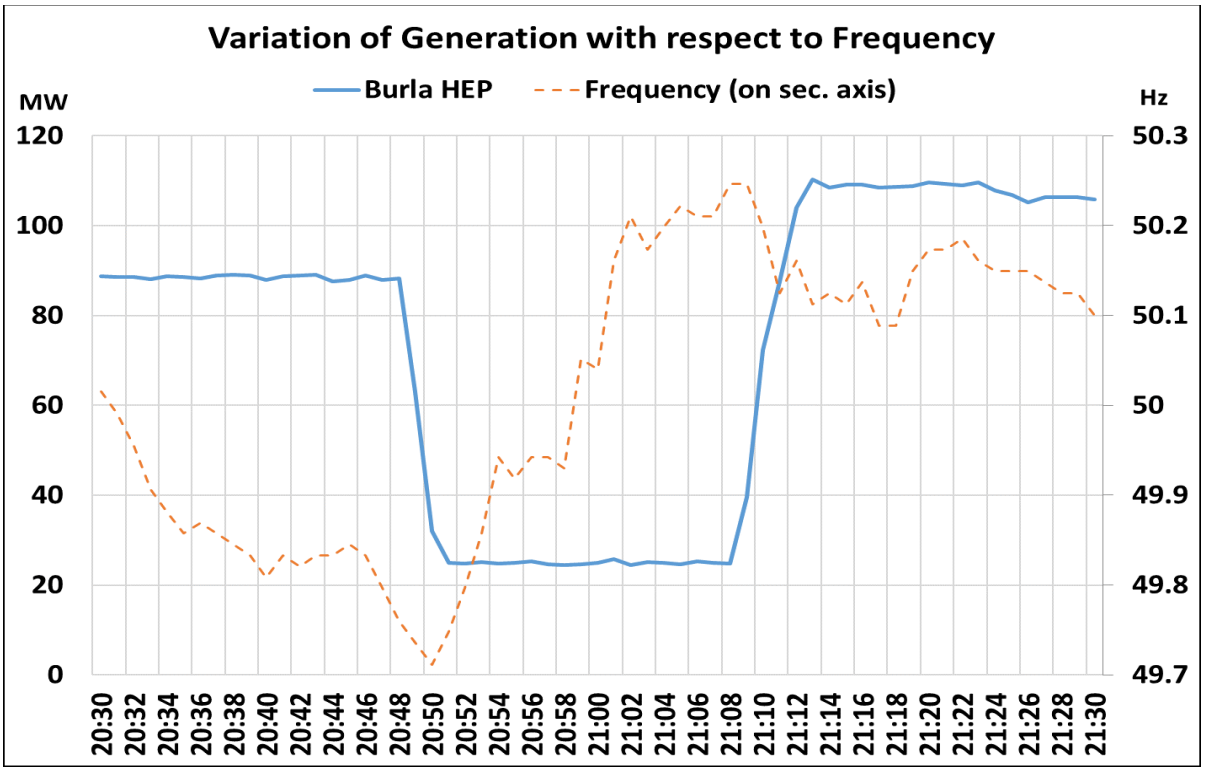
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Burla HEP
Frequency (on sec. axis)
MW
Hz
120
100
80
60
40
20
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
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21:10
21:12
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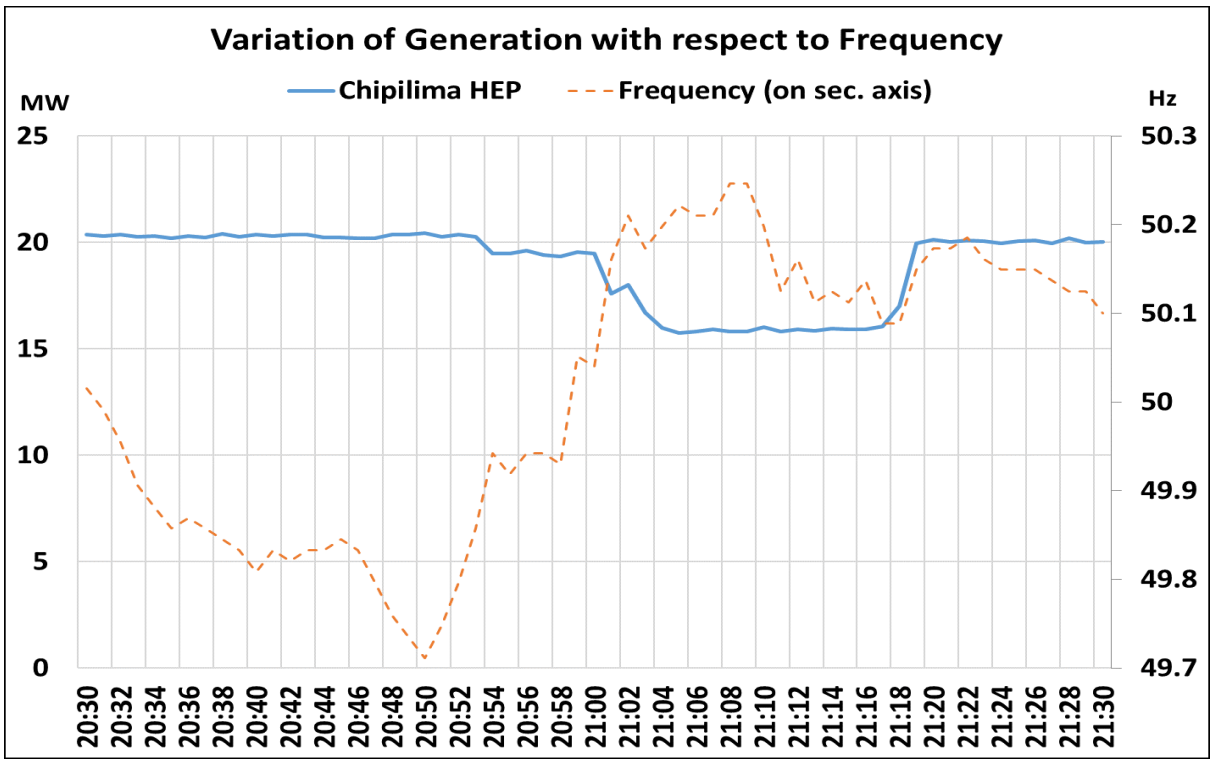
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Chipilima HEP
Frequency (on sec. axis)
MW
Hz
25
20
15
10
5
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
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21:10
21:12
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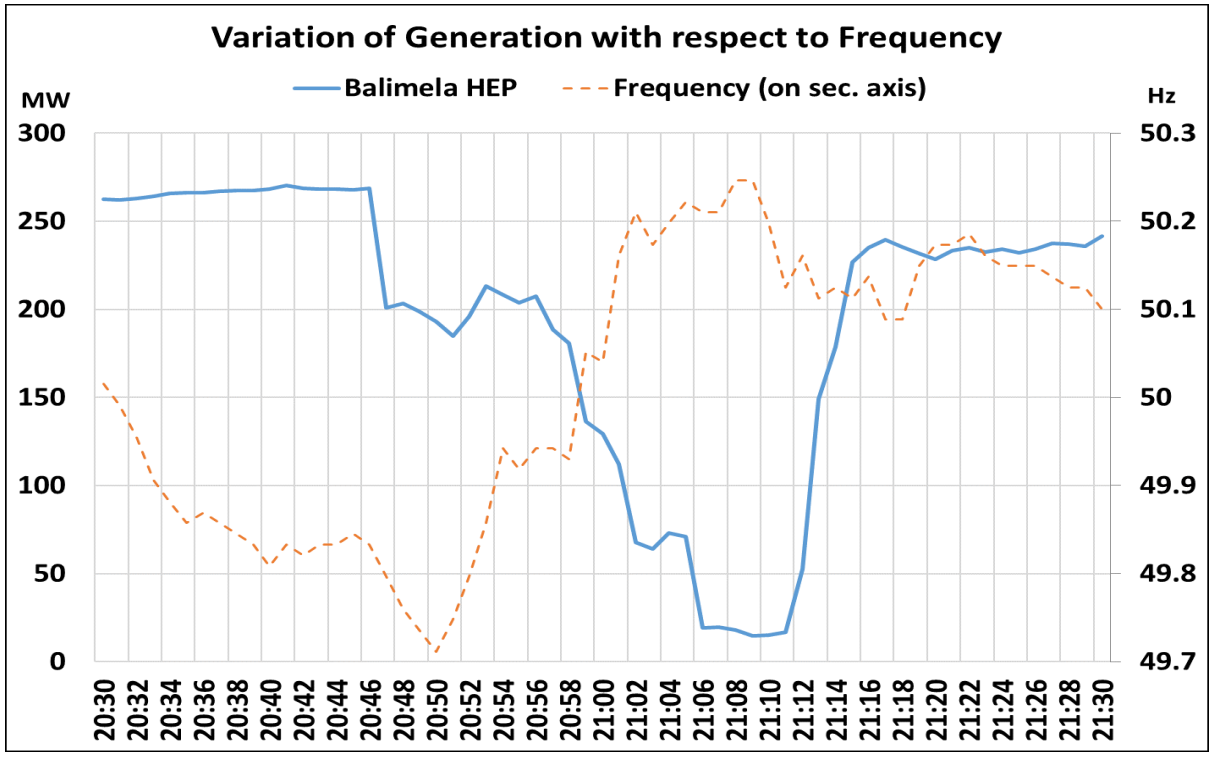
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Balimela HEP
Frequency (on sec. axis)
MW
Hz
300
250
200
150
100
50
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
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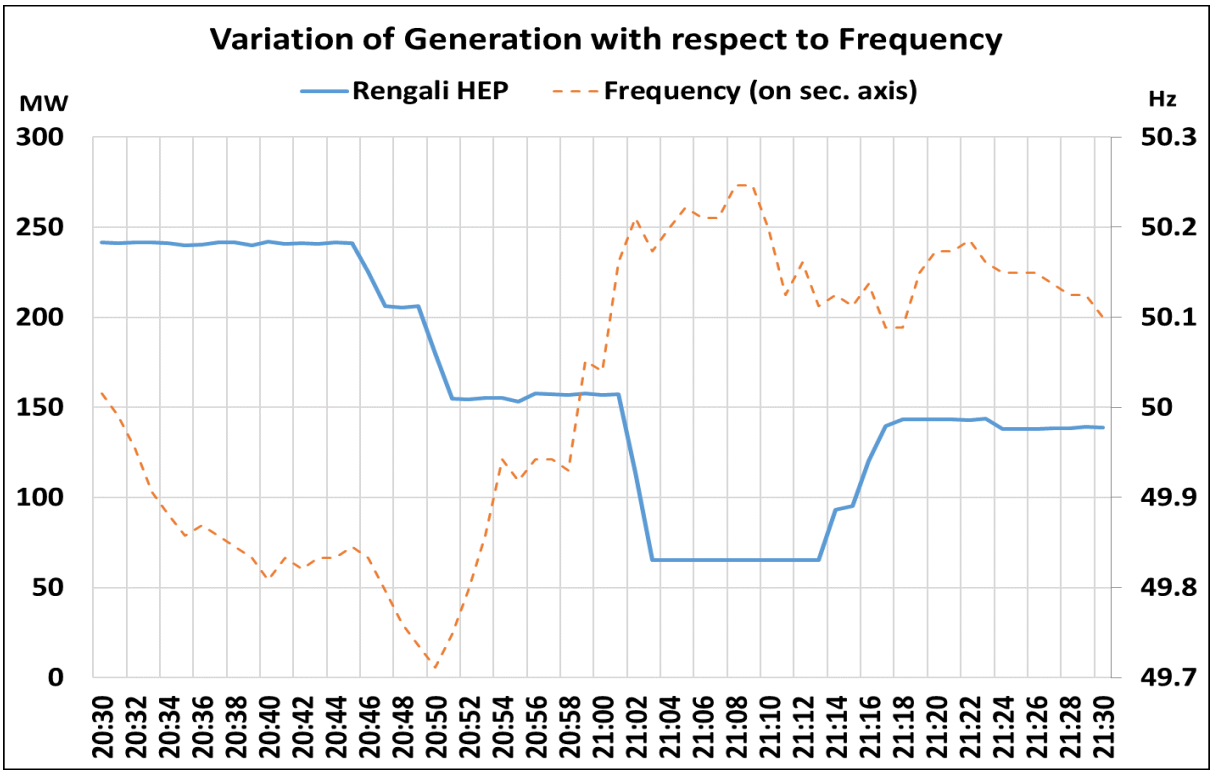
21:28
21:30


Variation of Generation with respect to Frequency
Rengali HEP
Frequency (on sec. axis)
MW
Hz
300
250
200
150
100
50
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
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21:22
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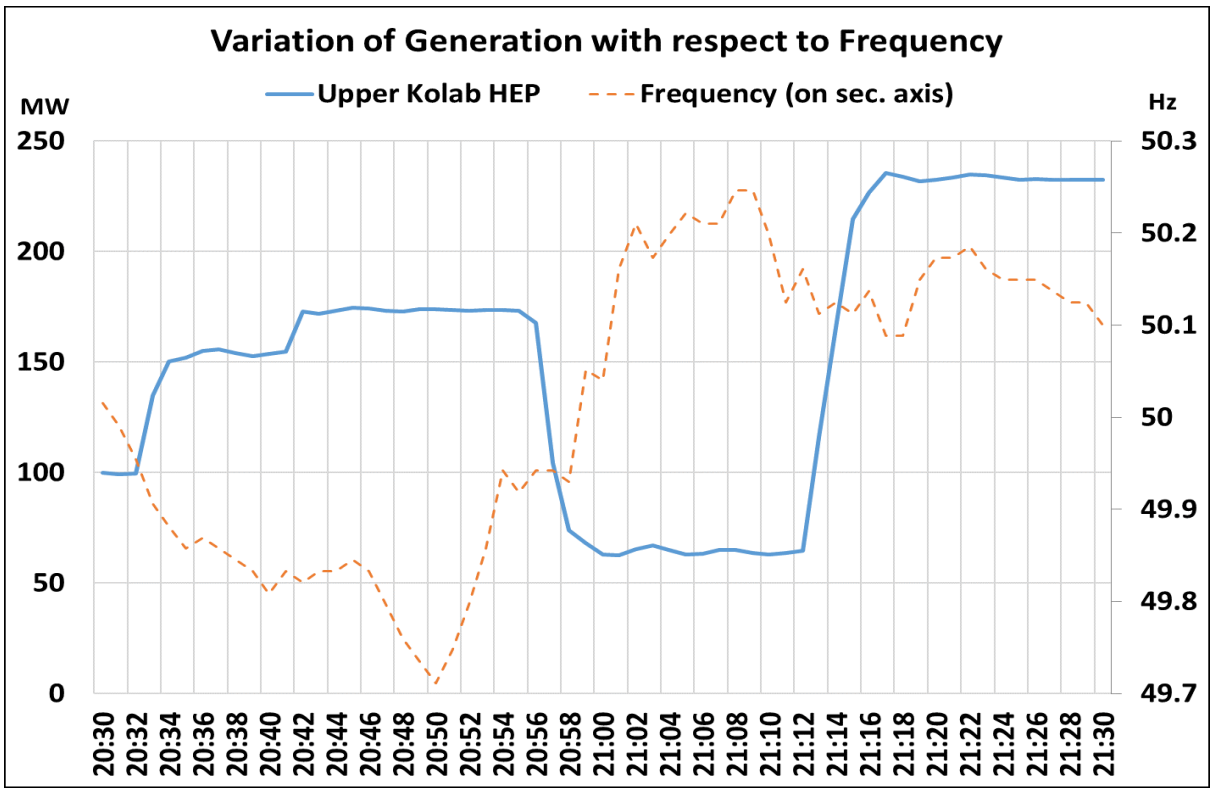
21:28
21:30


Variation of Generation with respect to Frequency
Upper Kolab HEP
Frequency (on sec. axis)
MW
Hz
250
200
150
100
50
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
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21:04
21:06
21:08
21:10
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21:16
21:18
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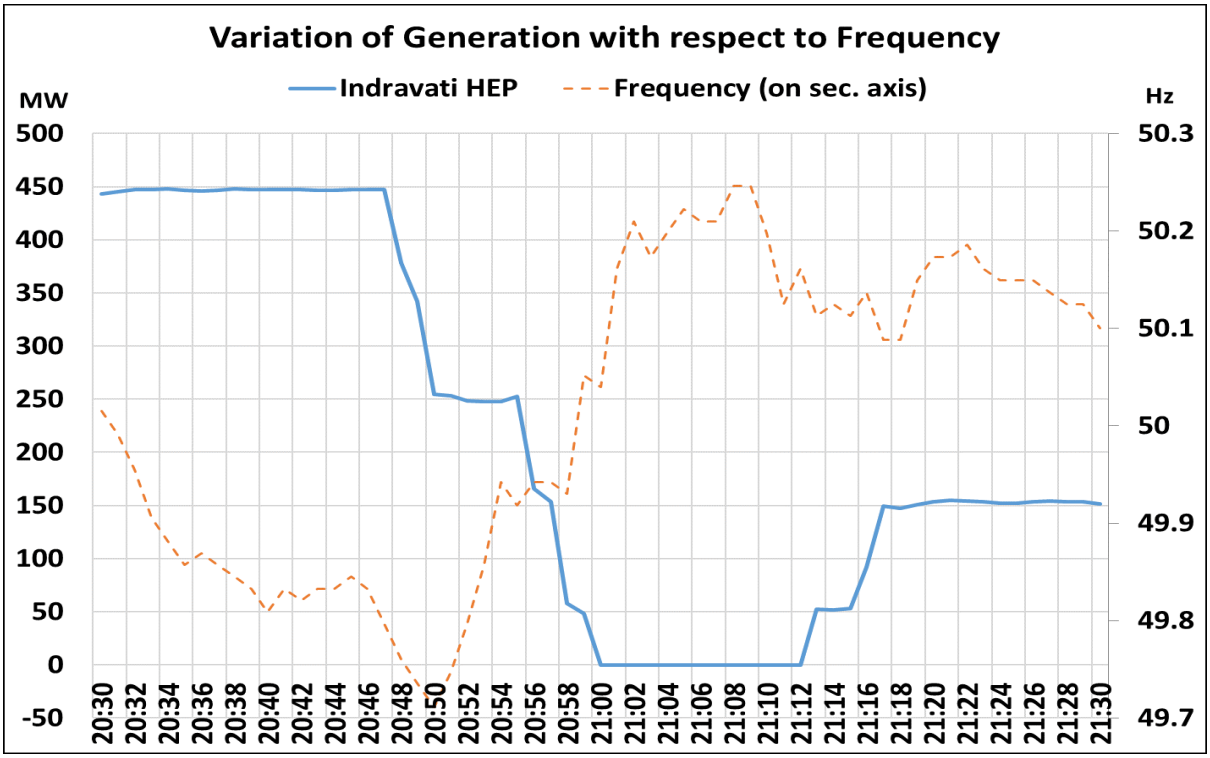
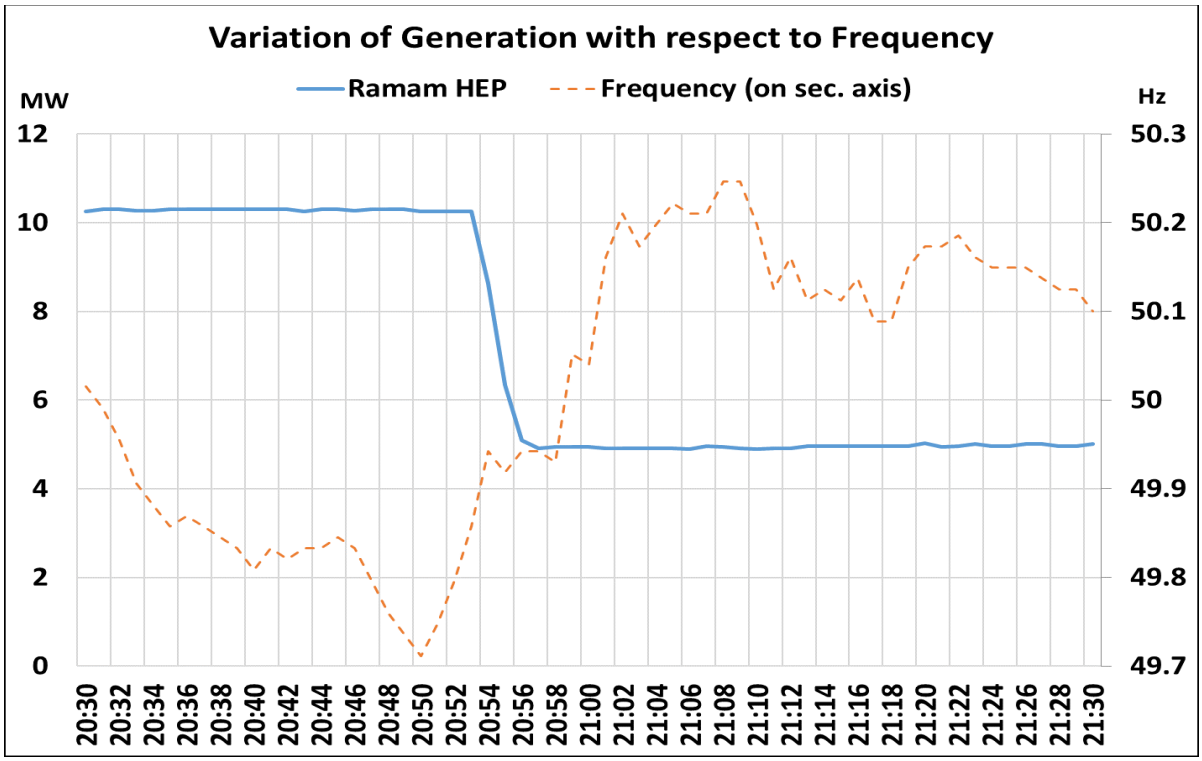
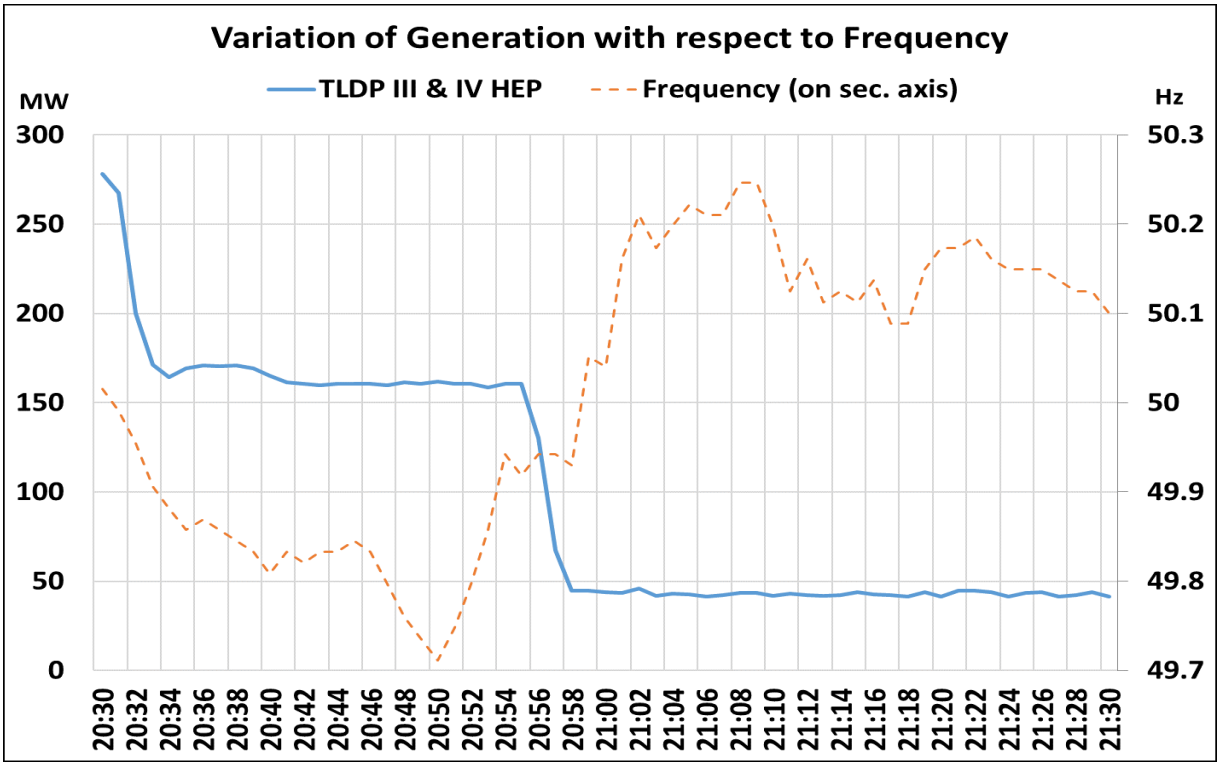
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Indravati HEP
Frequency (on sec. axis)
MW
Hz
500
450
400
350
300
250
200
150
100
50
0
-50
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
Ramam HEP
Frequency (on sec. axis)
MW
Hz
12
10
8
6
4
2
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
TLDP III & IV HEP
Frequency (on sec. axis)
MW
Hz
300
250
200
150
100
50
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
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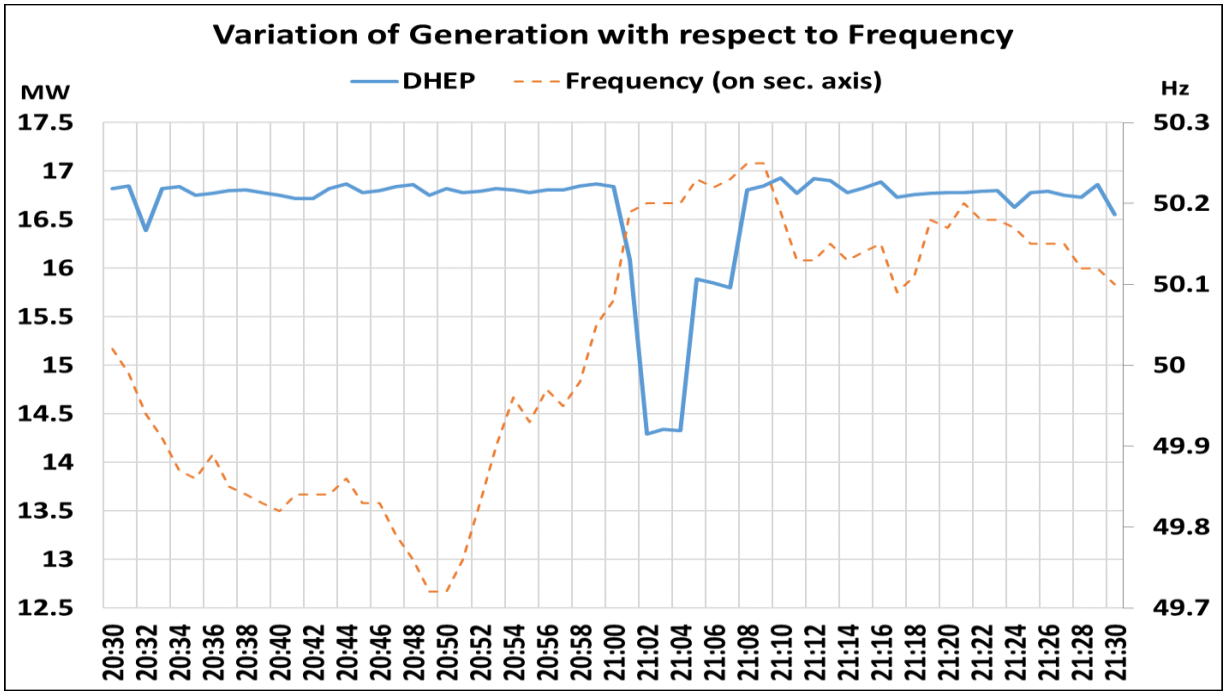
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
DHEP
Frequency (on sec. axis)
MW
Hz
17.5
17
16.5
16
15.5
15
14.5
14
13.5
13
12.5
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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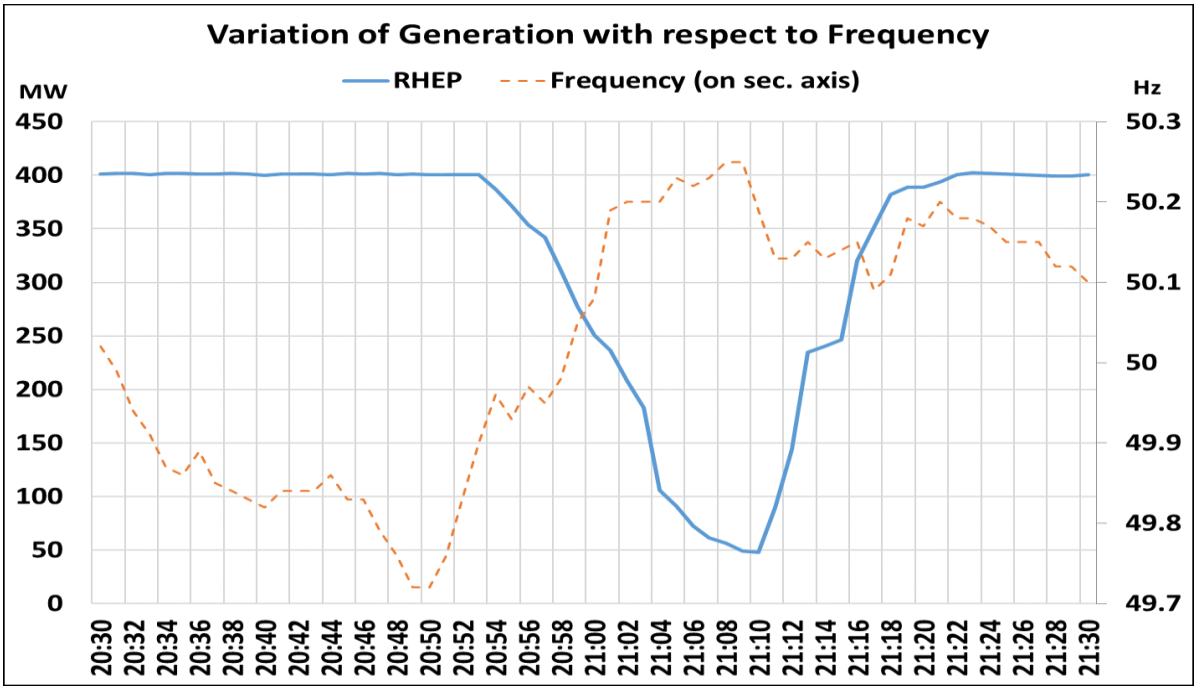
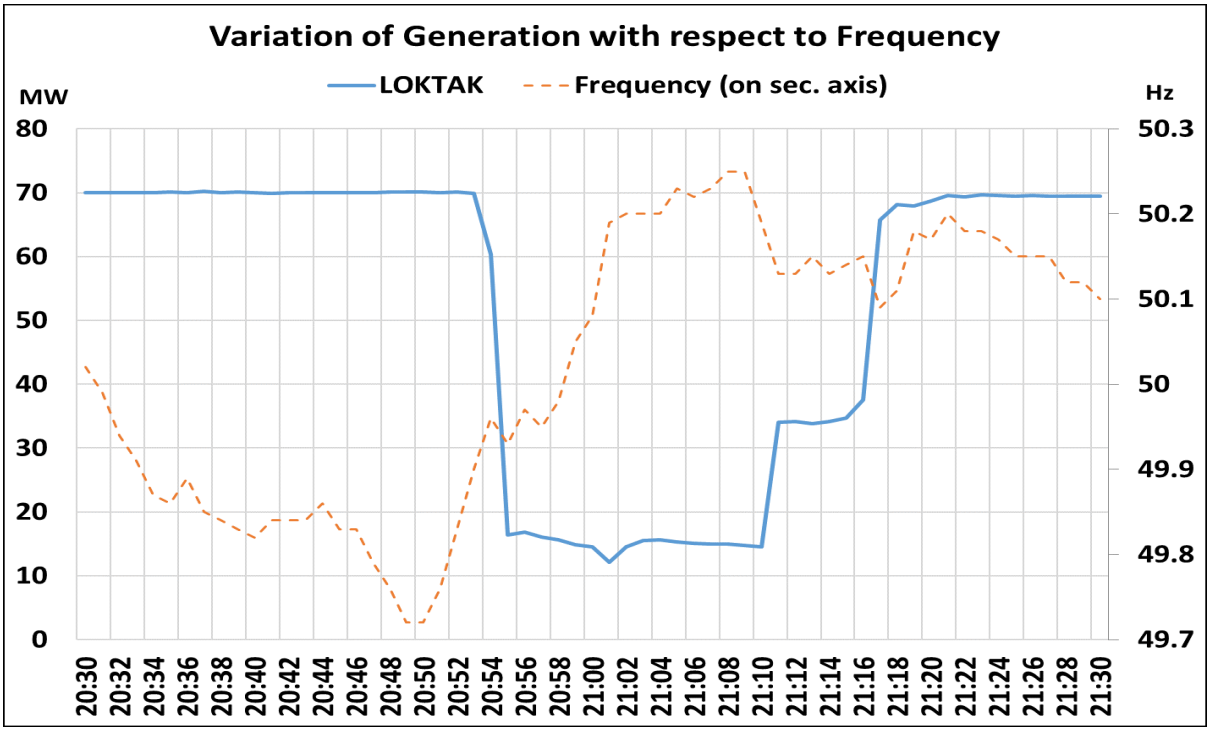
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
RHEP
Frequency (on sec. axis)
MW
Hz
450
400
350
300
250
200
150
100
50
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
LOKTAK
Frequency (on sec. axis)
MW
Hz
80
70
60
50
40
30
20
10
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
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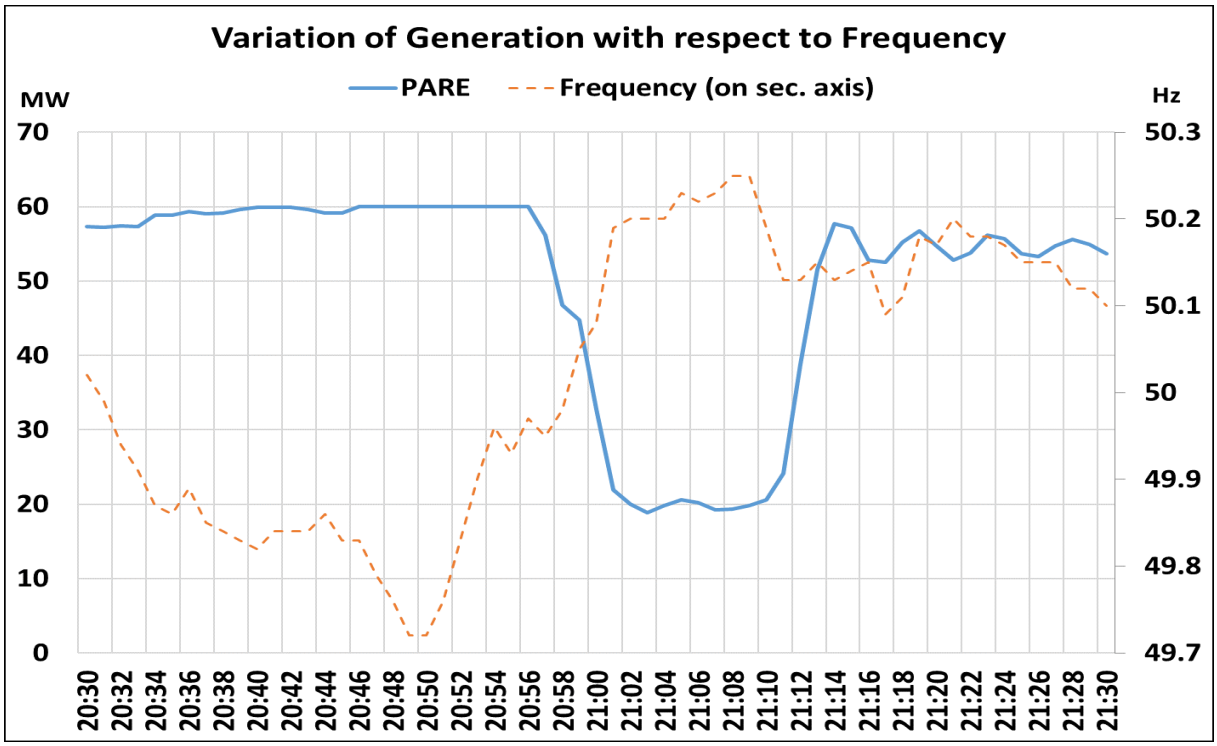
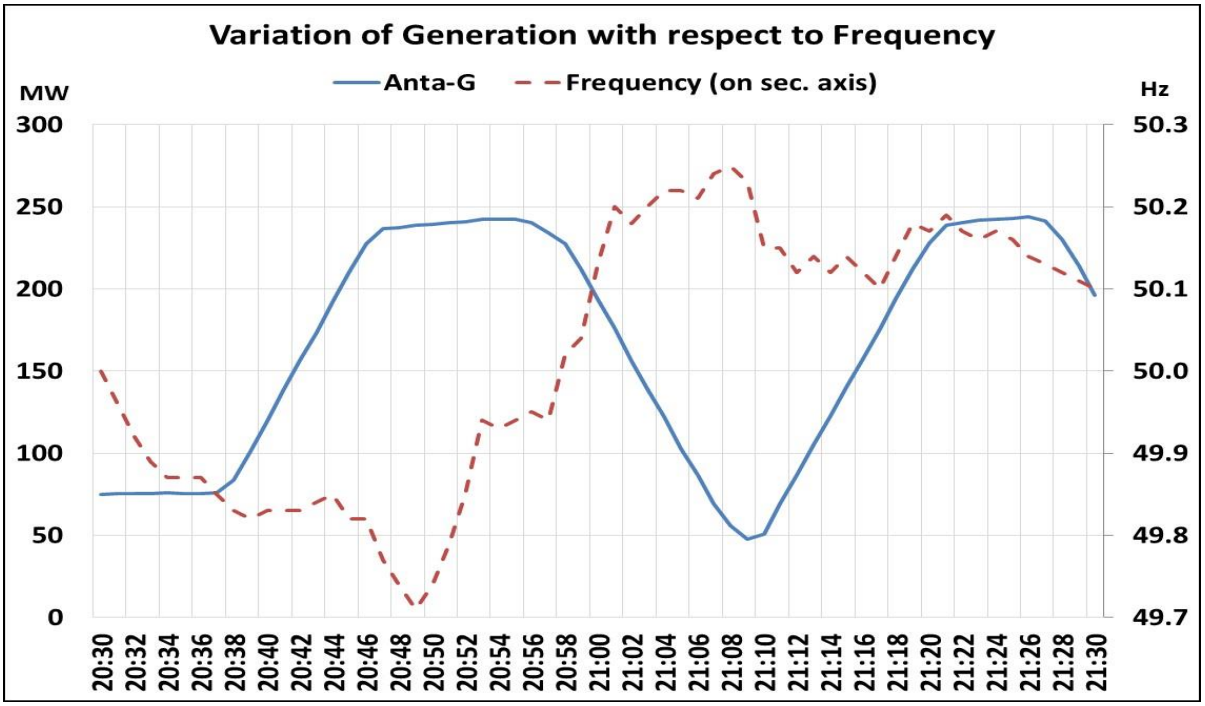
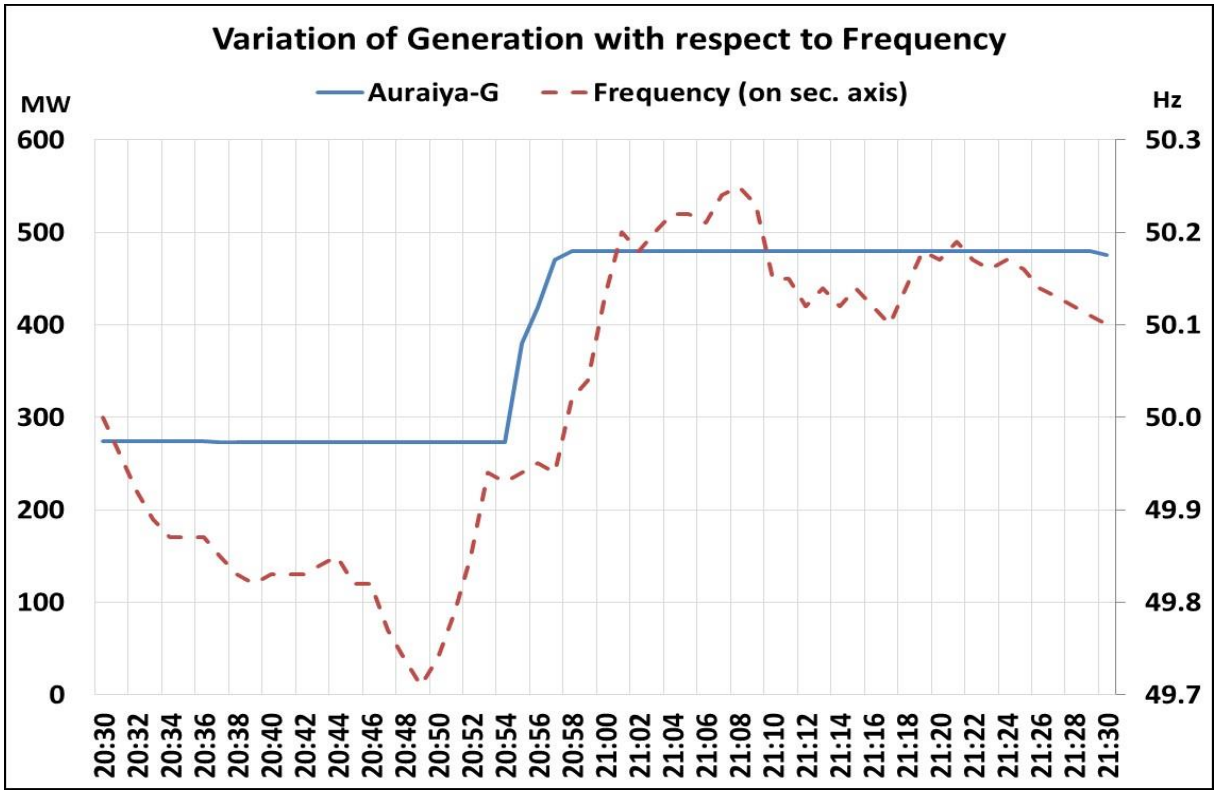
21:28
21:30

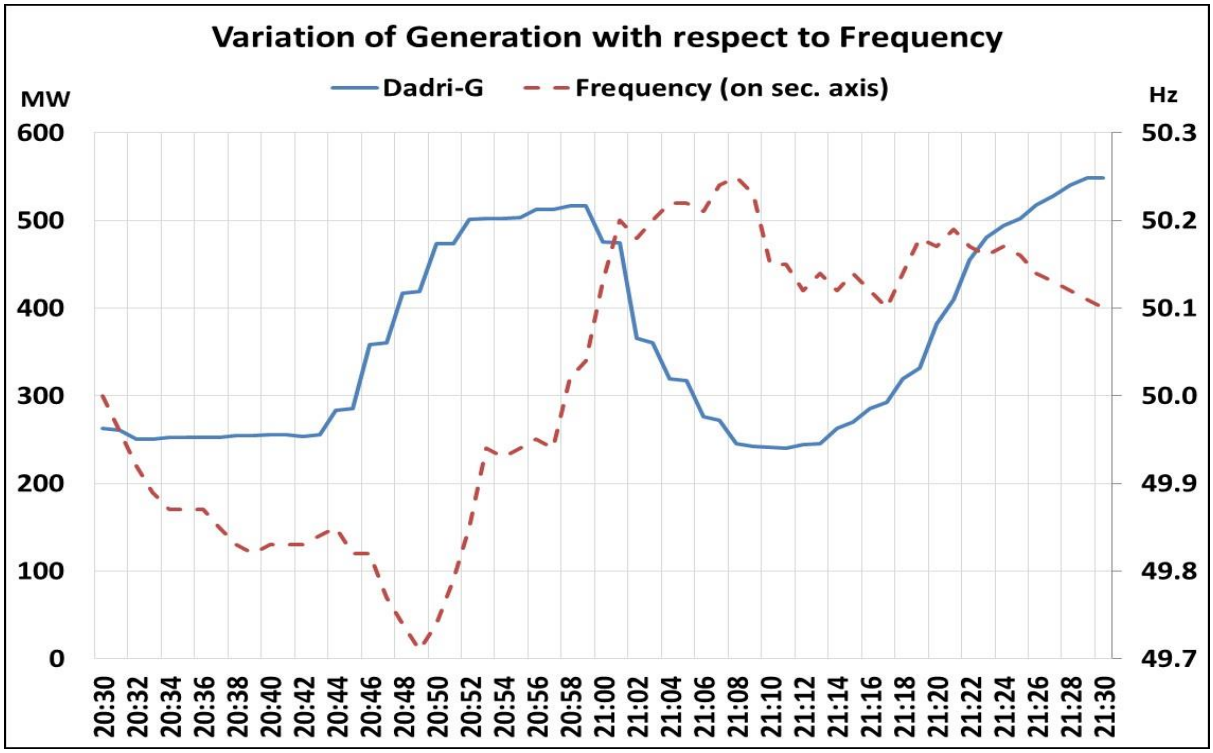

Variation of Generation with respect to Frequency
PARE
Frequency (on sec. axis)
MW
Hz
70
60
50
40
30
20
10
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

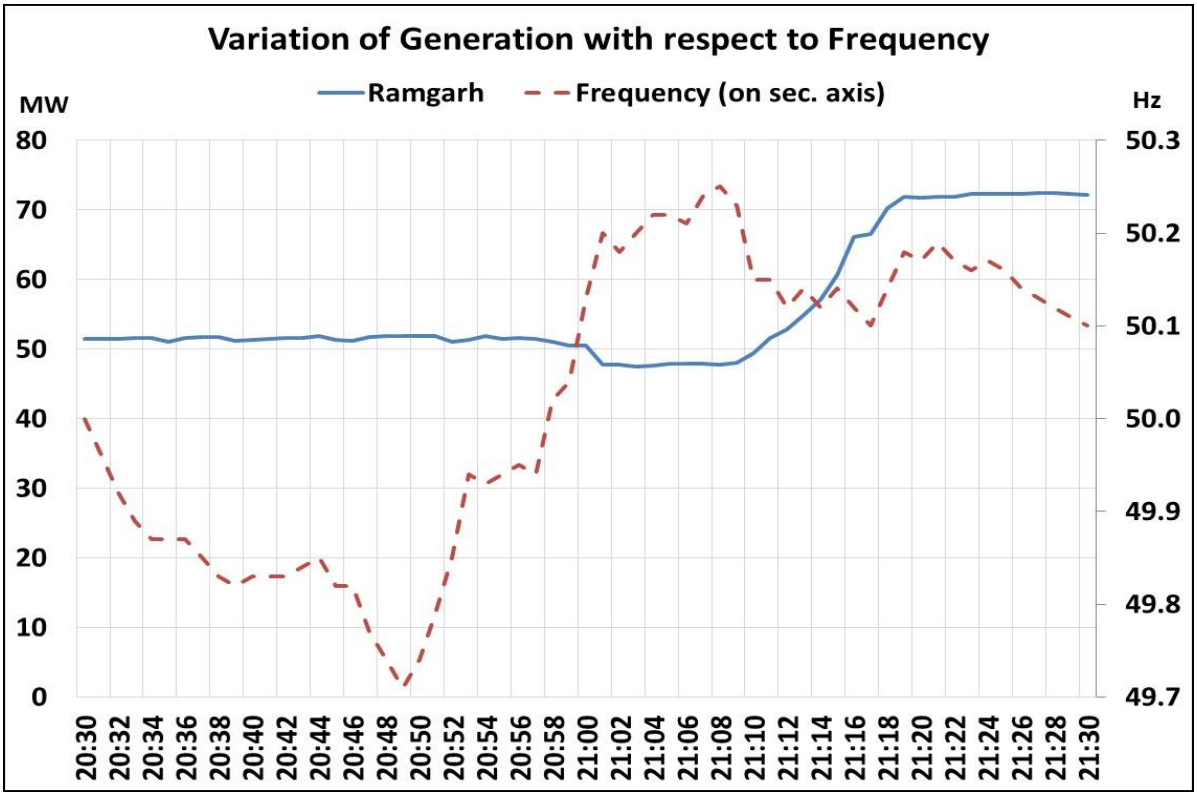
Annexure 7.4 Plant Wise Gas Generation

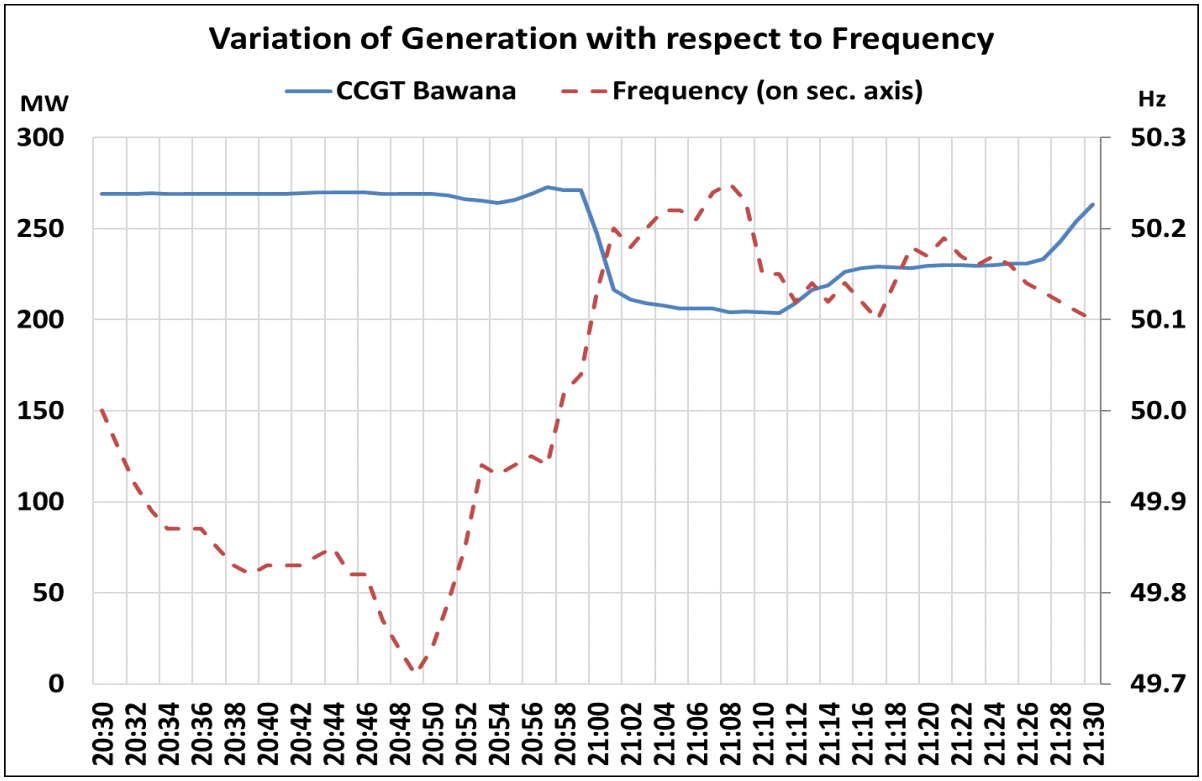
Northern Region

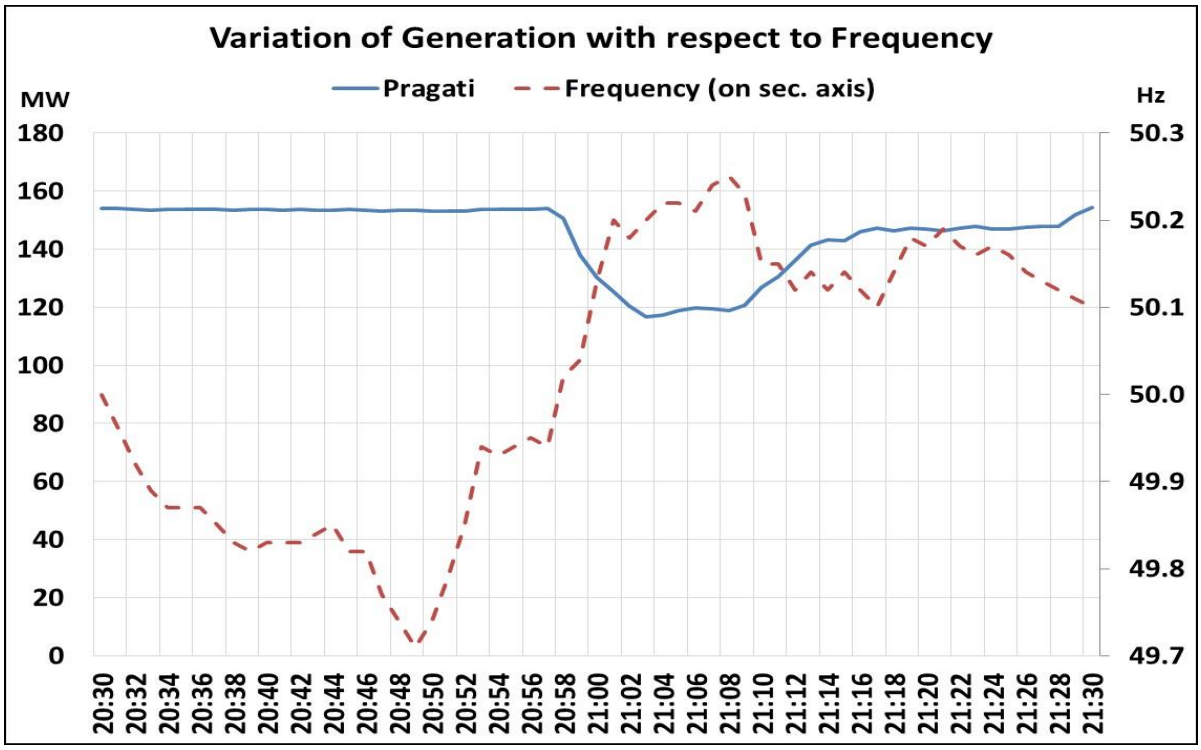




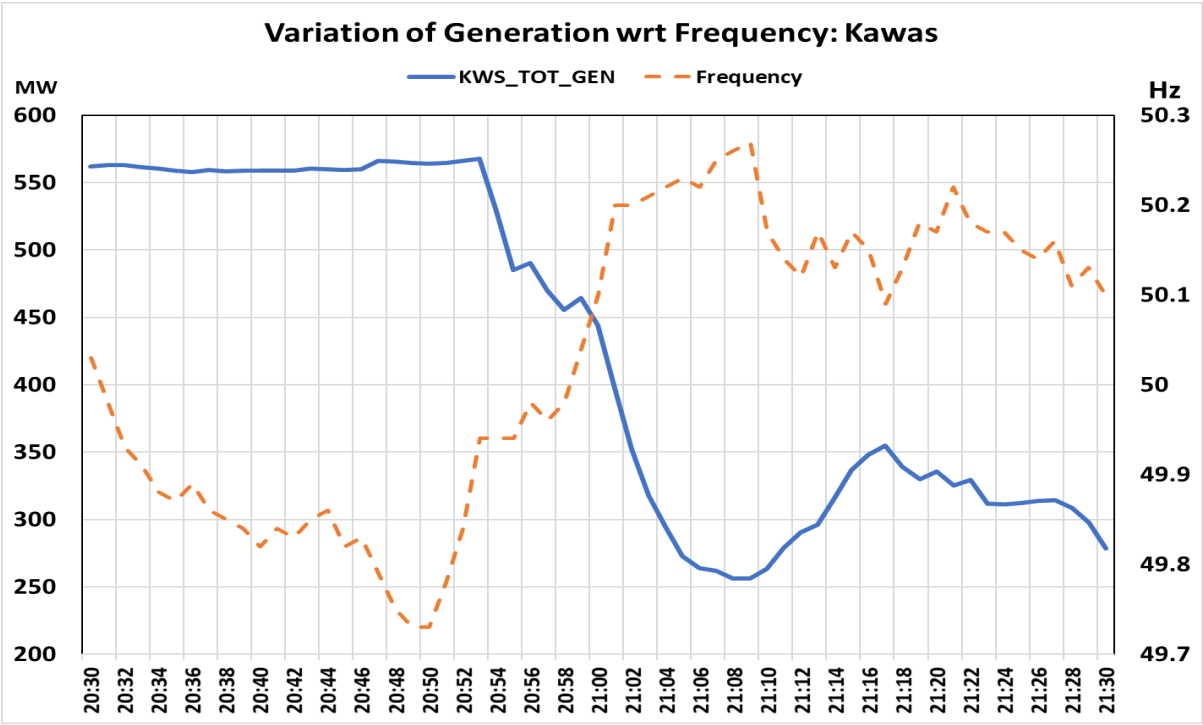

Variation of Generation with respect to Frequency
Dadri-G
Frequency (on sec. axis)
MW
Hz
600
500
400
300
200
100
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

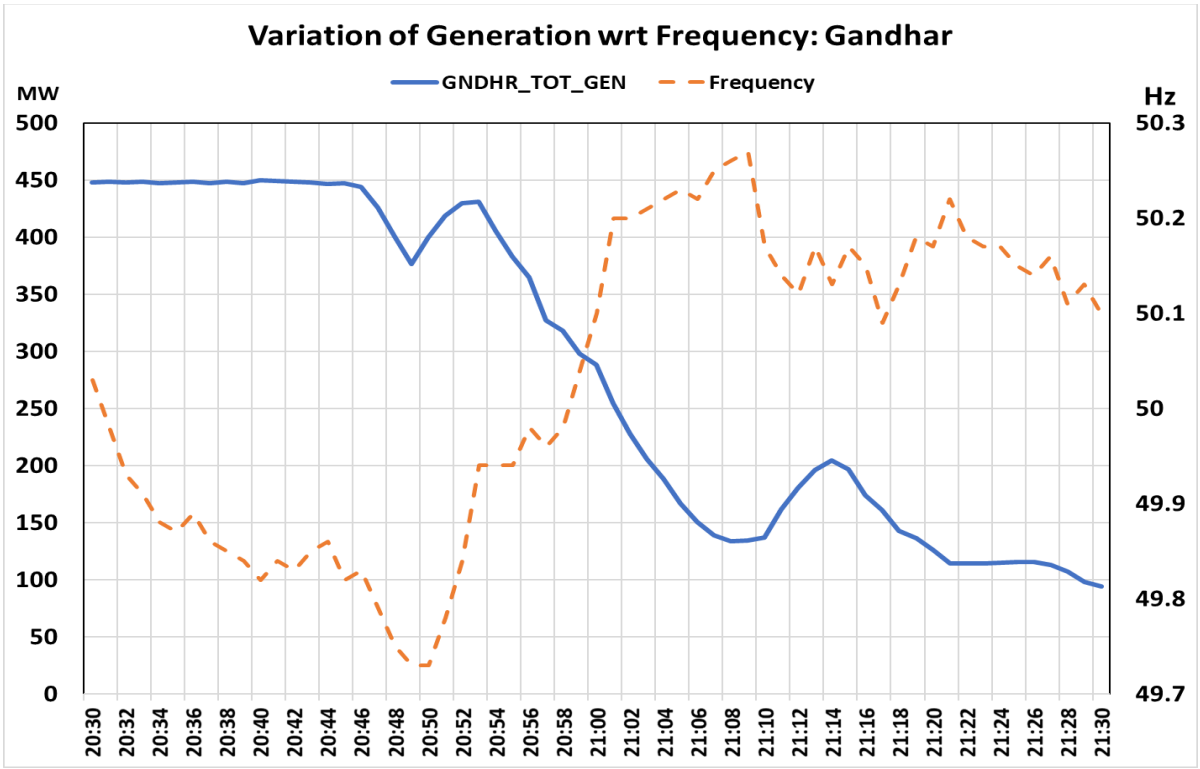

Variation of Generation with respect to Frequency
Ramgarh
Frequency (on sec. axis)
MW
Hz
80
70
60
50
40
30
20
10
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

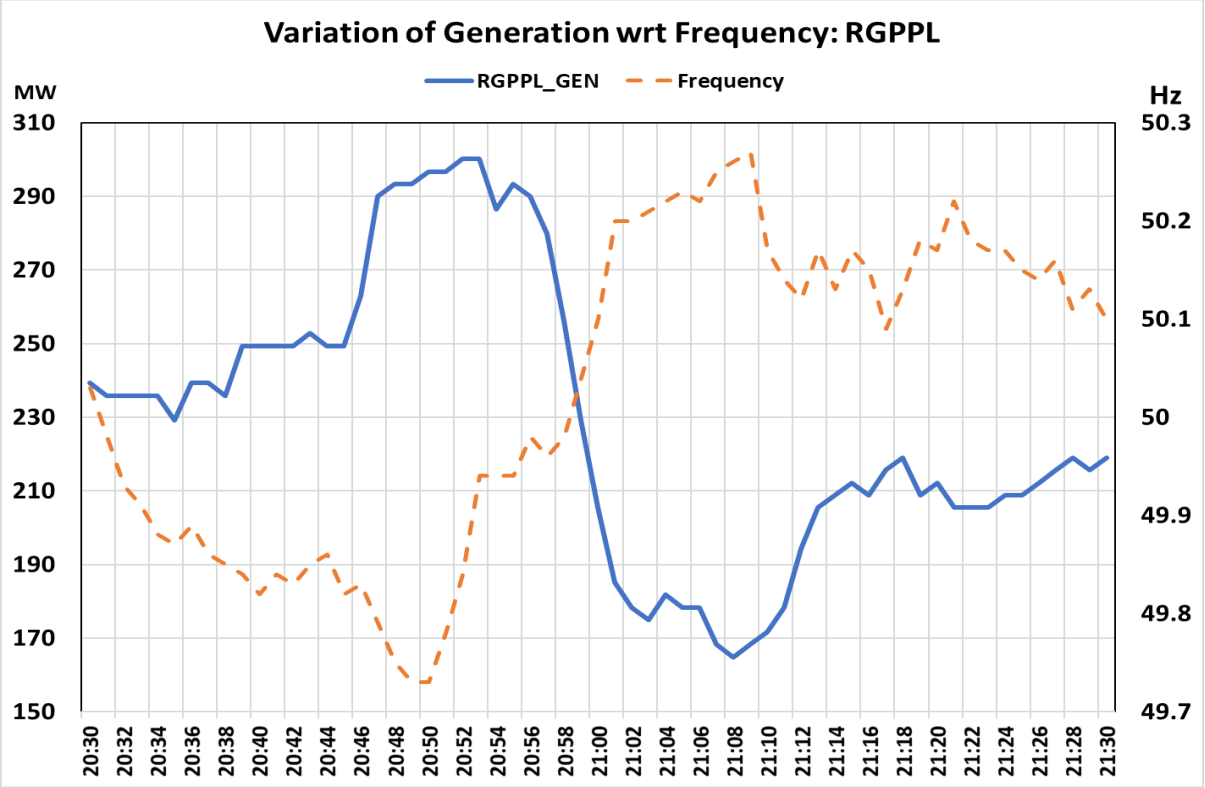

Variation of Generation with respect to Frequency
CCGT Bawana
Frequency (on sec. axis)
MW
Hz
300
250
200
150
100
50
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

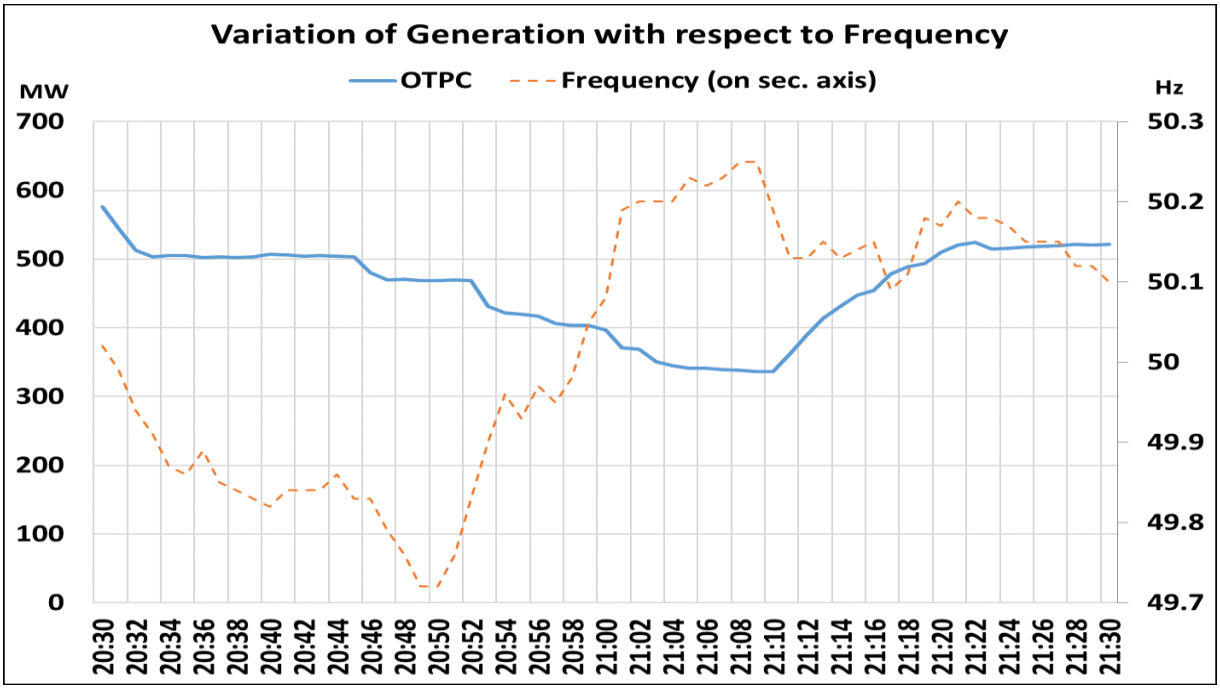

Variation of Generation with respect to Frequency
Pragati
Frequency (on sec. axis)
MW
Hz
180
160
140
120
100
80
60
40
20
0
50.3
50.2
50.1
50.0
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

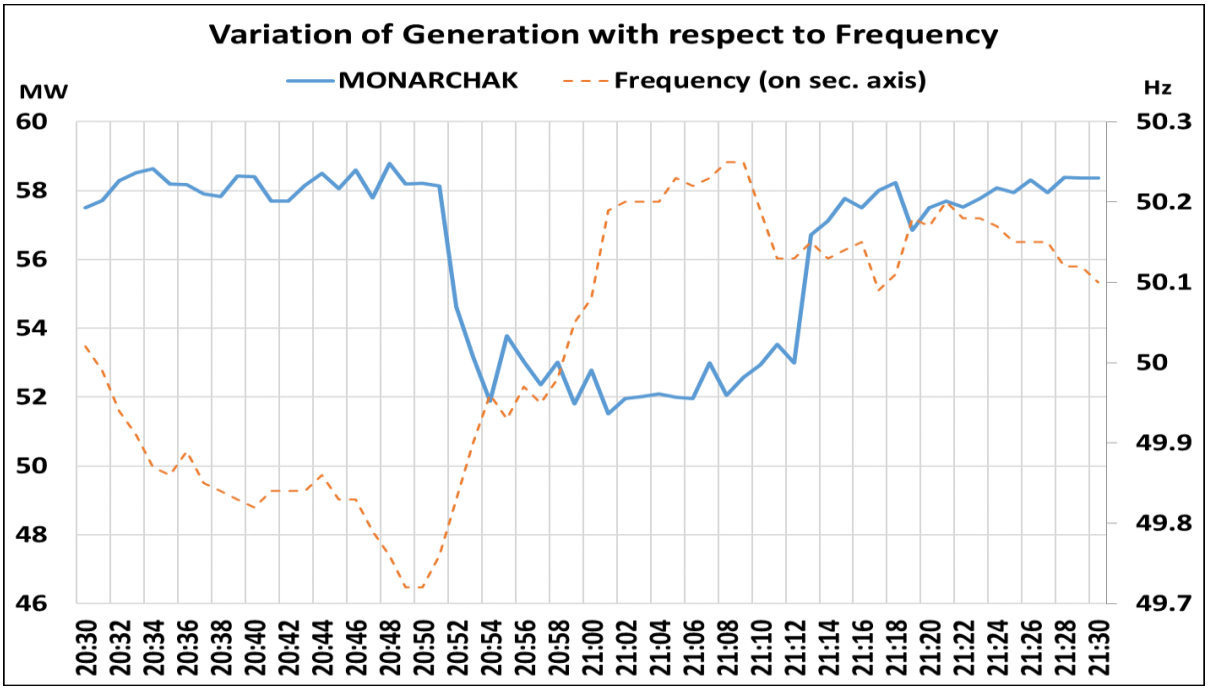
Western Region






Variation of Generation wrt Frequency: RGPPL
RGPPL_GEN
Frequency
MW
Hz
310
290
270
250
230
210
190
170
150
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
OTPC
Frequency (on sec. axis)
MW
Hz
700
600
500
400
300
200
100
0
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Generation with respect to Frequency
MONARCHAK
Frequency (on sec. axis)
MW
Hz
60
58
56
54
52
50
48
46
50.3
50.2
50.1
50
49.9
49.8
49.7
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
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21:30

Annexure 7.5 Minute wise Data of all India and Thermal Generation

Thermal Generation

Thermal Generation (MW) - 5 Apr 2020						
Time (hrs)	**NR**	**WR**	**SR**	**ER**	**NER**	**All India**
20:30	13319	31050	17897	14955	388	**77609**
20:31	13265	30887	17899	14884	389	**77324**
20:32	13225	30790	17884	14823	389	**77110**
20:33	13106	30729	17906	14856	386	**76983**
20:34	13026	30741	17896	14804	386	**76855**
20:35	13001	30701	17860	14786	387	**76735**
20:36	12991	30642	17818	14771	388	**76609**
20:37	12950	30608	17804	14781	386	**76530**
20:38	12908	30555	17782	14773	384	**76403**
20:39	12895	30516	17744	14742	384	**76280**
20:40	12880	30409	17702	14691	385	**76067**
20:41	12866	30315	17677	14651	383	**75892**
20:42	12846	30251	17651	14615	384	**75748**
20:43	12775	30216	17667	14548	385	**75591**
20:44	12883	30105	17655	14487	386	**75515**
20:45	12903	29915	17622	14444	393	**75277**
20:46	12955	29776	17567	14432	391	**75121**
20:47	13020	29662	17526	14340	393	**74941**
20:48	13116	29578	17529	14299	395	**74918**
20:49	13148	29457	17518	14276	398	**74797**
20:50	13171	29401	17521	14225	397	**74716**
20:51	13184	29326	17496	14208	402	**74616**
20:52	13208	29235	17484	14165	407	**74498**
20:53	13193	29104	17438	14121	414	**74270**
20:54	13232	29030	17406	14061	415	**74145**
20:55	13202	28959	17459	13996	420	**74037**
20:56	13194	28832	17431	13931	423	**73811**
20:57	13170	28760	17365	13881	424	**73600**
20:58	13143	28598	17328	13823	420	**73311**
20:59	12953	28358	17212	13804	413	**72740**
21:00	12715	28167	17131	13748	410	**72170**
21:01	12589	27534	16778	13750	408	**71060**
21:02	12406	27328	16594	13609	394	**70331**
21:03	12246	27077	16532	13514	386	**69756**
21:04	11982	26771	16527	13514	385	**69179**
21:05	11833	26580	16509	13506	384	**68811**

Thermal Generation (MW) - 5 Apr 2020						
Time (hrs)	**NR**	**WR**	**SR**	**ER**	**NER**	**All India**
21:06	11696	26380	16418	13454	377	**68325**
21:07	11606	26287	16384	13462	380	**68119**
21:08	11579	26164	16324	13499	377	**67942**
21:09	11580	26118	16304	13581	370	**67952**
21:10	11536	26122	16343	13672	365	**68037**
21:11	11259	26276	16429	13752	363	**68079**
21:12	11354	26401	16475	13829	366	**68425**
21:13	11456	26653	16550	13982	361	**69001**
21:14	11483	27023	16634	14122	376	**69638**
21:15	11483	27262	16731	14192	384	**70052**
21:16	11530	27490	16818	14333	392	**70564**
21:17	11609	27784	16952	14464	398	**71207**
21:18	11633	27928	17101	14602	406	**71670**
21:19	11702	28141	17191	14715	416	**72165**
21:20	11718	28313	17264	14735	429	**72460**
21:21	11870	28485	17396	14797	436	**72985**
21:22	11911	28626	17515	14853	447	**73353**
21:23	11974	28794	17574	14954	451	**73746**
21:24	11962	28981	17607	15051	461	**74062**
21:25	11992	29115	17662	15114	466	**74348**
21:26	11986	29203	17705	15201	474	**74568**
21:27	11935	29326	17731	15257	474	**74723**
21:28	11874	29389	17778	15362	472	**74874**
21:29	11854	29446	17994	15483	460	**75235**
21:30	11991	29523	18148	15553	446	**75661**

Hydro Generation

Hydro Generation (MW) - 5 Apr 2020						
Time (hrs)	**NR**	**WR**	**SR**	**ER**	**NER**	**All India**
20:30	12173	2905	4232	4333	617	**24261**
20:31	12291	2905	4360	4326	617	**24499**
20:32	12557	2905	4393	3980	618	**24453**
20:33	12593	3143	4479	3968	616	**24799**
20:34	12604	3198	4707	3993	620	**25121**
20:35	12619	3203	4834	4030	620	**25306**
20:36	12617	3209	4957	4048	619	**25449**
20:37	12574	3209	5042	4058	619	**25501**
20:38	12527	3212	5103	4048	619	**25509**
20:39	12539	3207	5111	4075	619	**25551**
20:40	12557	3221	5154	3926	620	**25477**
20:41	12520	3228	5261	3893	620	**25521**
20:42	12466	3233	5299	3898	619	**25515**
20:43	12427	3223	5361	3848	619	**25478**
20:44	12331	3225	5431	3867	622	**25475**
20:45	12358	3219	5475	3880	628	**25559**
20:46	12402	3218	5557	3879	621	**25676**
20:47	12233	3218	5827	3536	620	**25434**
20:48	12241	3179	5841	3413	643	**25316**
20:49	12170	3172	5828	3361	645	**25176**
20:50	12170	3177	5583	3263	645	**24838**
20:51	12151	3234	5475	3087	645	**24592**
20:52	12013	3243	5368	3092	646	**24362**
20:53	11878	3220	5367	3073	673	**24212**
20:54	11391	3170	5587	3066	672	**23886**
20:55	10559	3078	5598	2995	618	**22848**
20:56	9866	2914	5635	2939	567	**21921**
20:57	9376	2568	5570	2750	553	**20817**
20:58	8396	2171	5615	2285	499	**18965**
20:59	7975	1992	5456	1776	419	**17618**
21:00	6644	1797	4601	1474	374	**14890**
21:01	5531	1659	3415	1262	356	**12222**
21:02	4894	1533	2731	1008	314	**10480**
21:03	4478	1437	2421	730	291	**9357**
21:04	4433	1411	2327	675	244	**9091**
21:05	4340	1361	2318	737	199	**8955**
21:06	4213	1345	2313	701	172	**8743**
21:07	4081	1327	2316	674	171	**8569**

Hydro Generation (MW) - 5 Apr 2020						
Time (hrs)	**NR**	**WR**	**SR**	**ER**	**NER**	**All India**
21:08	3961	1298	2203	673	159	**8293**
21:09	3866	1237	2096	670	150	**8019**
21:10	3881	1259	2039	690	146	**8016**
21:11	4390	1437	2093	729	169	**8817**
21:12	5440	1926	2165	874	260	**10664**
21:13	6406	2465	2363	1039	369	**12641**
21:14	7016	2488	2433	1361	451	**13750**
21:15	7324	2570	2564	1607	455	**14520**
21:16	7410	2636	2720	1796	475	**15037**
21:17	7343	2791	2875	2012	527	**15548**
21:18	7570	2870	3120	2208	618	**16385**
21:19	7940	2955	3018	2286	638	**16837**
21:20	8325	2941	3092	2636	632	**17625**
21:21	8385	2902	3186	2878	634	**17985**
21:22	8530	2892	3230	2872	614	**18138**
21:23	8631	2918	3378	2753	617	**18298**
21:24	8702	2922	3397	2716	620	**18357**
21:25	8944	2931	3393	2725	618	**18612**
21:26	9099	2930	3446	2715	605	**18796**
21:27	9278	2934	3457	2741	603	**19012**
21:28	9165	2941	3486	2768	598	**18958**
21:29	9145	2949	3464	2815	597	**18970**
21:30	8997	2961	3469	2905	591	**18923**

Gas Generation

Gas Generation (MW) - 5 Apr 2020						
Time	NR	WR	SR	ER	NER	All India
20:30	1159	4485	733		880	**7257**
20:31	1154	4458	682		869	**7163**
20:32	1154	4436	694		816	**7099**
20:33	1142	4430	682		798	**7052**
20:34	1141	4430	680		798	**7049**
20:35	1145	4438	657		796	**7037**
20:36	1144	4439	701		792	**7077**
20:37	1142	4446	709		793	**7091**
20:38	1142	4446	698		793	**7079**
20:39	1152	4456	690		792	**7090**
20:40	1171	4514	660		797	**7142**
20:41	1192	4526	652		794	**7164**
20:42	1210	4565	705		794	**7273**
20:43	1227	4558	697		795	**7276**
20:44	1244	4565	698		795	**7302**
20:45	1292	4543	674		796	**7305**
20:46	1309	4538	698		788	**7333**
20:47	1401	4540	701		752	**7395**
20:48	1410	4525	709		753	**7397**
20:49	1468	4506	709		754	**7436**
20:50	1470	4498	704		747	**7419**
20:51	1526	4516	713		741	**7495**
20:52	1526	4525	694		739	**7484**
20:53	1552	4547	691		723	**7512**
20:54	1551	4491	688		682	**7412**
20:55	1554	4409	686		687	**7336**
20:56	1704	4316	682		683	**7385**
20:57	1713	4223	682		673	**7291**
20:58	1773	4115	690		664	**7241**
20:59	1767	3961	675		657	**7060**
21:00	1733	3809	665		659	**6865**
21:01	1622	3578	675		651	**6526**
21:02	1579	3398	656		626	**6259**
21:03	1439	3273	643		619	**5974**
21:04	1420	3208	637		602	**5867**
21:05	1353	3137	644		596	**5730**
21:06	1338	3037	642		596	**5613**
21:07	1277	2992	642		597	**5508**

Gas Generation (MW) - 5 Apr 2020						
Time	**NR**	**WR**	**SR**	**ER**	**NER**	**All India**
21:08	1259	2930	639		595	**5423**
21:09	1213	2921	641		598	**5372**
21:10	1210	2909	638		598	**5355**
21:11	1224	2936	643		631	**5433**
21:12	1241	3028	646		650	**5565**
21:13	1281	3149	673		689	**5791**
21:14	1315	3289	678		714	**5996**
21:15	1366	3386	697		750	**6199**
21:16	1389	3446	708		759	**6301**
21:17	1442	3557	711		763	**6472**
21:18	1460	3639	698		803	**6599**
21:19	1523	3653	701		811	**6688**
21:20	1541	3699	673		822	**6734**
21:21	1637	3729	664		839	**6868**
21:22	1643	3737	687		842	**6909**
21:23	1715	3766	671		844	**6997**
21:24	1720	3770	668		837	**6995**
21:25	1742	3803	662		838	**7045**
21:26	1742	3831	653		841	**7067**
21:27	1769	3857	661		842	**7129**
21:28	1777	3867	677		843	**7164**
21:29	1790	3868	660		844	**7163**
21:30	1792	3865	667		851	**7175**

Wind Generation

Wind Generation (MW) - 5 Apr 2020						
Time	NR	WR	SR	ER	NER	All India
20:30	270	1880	1572			**3722**
20:31	274	1879	1601			**3754**
20:32	278	1852	1602			**3732**
20:33	278	1847	1572			**3697**
20:34	280	1845	1576			**3701**
20:35	292	1845	1584			**3721**
20:36	300	1836	1592			**3728**
20:37	309	1833	1587			**3729**
20:38	319	1833	1584			**3736**
20:39	320	1829	1576			**3725**
20:40	323	1827	1563			**3712**
20:41	332	1826	1519			**3677**
20:42	350	1829	1418			**3597**
20:43	355	1823	1377			**3555**
20:44	359	1826	1372			**3557**
20:45	368	1822	1373			**3564**
20:46	375	1804	1394			**3573**
20:47	411	1797	1393			**3601**
20:48	415	1794	1399			**3608**
20:49	425	1734	1388			**3547**
20:50	434	1731	1381			**3545**
20:51	434	1734	1385			**3553**
20:52	441	1719	1325			**3485**
20:53	447	1706	1294			**3446**
20:54	451	1702	1245			**3398**
20:55	455	1692	1258			**3406**
20:56	454	1683	1235			**3372**
20:57	459	1680	1216			**3354**
20:58	470	1680	1136			**3287**
20:59	470	1686	1123			**3279**
21:00	479	1679	1078			**3236**
21:01	482	1628	991			**3101**
21:02	421	1528	946			**2894**
21:03	288	1178	848			**2314**
21:04	129	906	813			**1848**
21:05	88	865	825			**1779**
21:06	15	811	832			**1658**
21:07	16	756	809			**1581**

Wind Generation (MW) - 5 Apr 2020						
Time	**NR**	**WR**	**SR**	**ER**	**NER**	**All India**
21:08	17	757	823			**1597**
21:09	16	749	827			**1591**
21:10	15	730	821			**1566**
21:11	10	714	779			**1503**
21:12	12	700	753			**1466**
21:13	13	697	788			**1498**
21:14	13	767	846			**1626**
21:15	11	791	871			**1673**
21:16	16	830	872			**1717**
21:17	9	854	881			**1743**
21:18	5	933	928			**1866**
21:19	10	958	948			**1916**
21:20	15	967	963			**1945**
21:21	13	1056	1020			**2090**
21:22	12	1169	1044			**2225**
21:23	14	1098	1084			**2197**
21:24	14	1129	1119			**2261**
21:25	10	1232	1183			**2425**
21:26	11	1237	1191			**2439**
21:27	13	1220	1188			**2421**
21:28	16	1226	1210			**2451**
21:29	16	1229	1247			**2492**
21:30	16	1233	1278			**2527**

Nuclear Generation (MW) - 5 Apr 2020						
Time	NR	WR	SR	ER	NER	All India
20:30	1210	1471	2245			**4927**
20:31	1210	1474	2267			**4950**
20:32	1210	1477	2268			**4955**
20:33	1210	1472	2269			**4951**
20:34	1210	1477	2259			**4946**
20:35	1210	1474	2261			**4946**
20:36	1210	1476	2254			**4940**
20:37	1210	1480	2244			**4933**
20:38	1210	1474	2252			**4935**
20:39	1210	1475	2257			**4942**
20:40	1210	1473	2250			**4933**
20:41	1210	1476	2246			**4933**
20:42	1210	1477	2250			**4937**
20:43	1210	1474	2245			**4928**
20:44	1210	1476	2245			**4931**
20:45	1210	1477	2241			**4929**
20:46	1210	1473	2256			**4939**
20:47	1210	1472	2249			**4931**
20:48	1210	1477	2260			**4947**
20:49	1210	1474	2255			**4940**
20:50	1210	1476	2250			**4936**
20:51	1210	1476	2244			**4931**
20:52	1210	1468	2227			**4905**
20:53	1210	1473	2232			**4915**
20:54	1210	1470	2244			**4924**
20:55	1210	1470	2261			**4942**
20:56	1210	1467	2243			**4919**
20:57	1210	1475	2237			**4922**
20:58	1210	1464	2256			**4930**
20:59	1210	1470	2211			**4891**
21:00	1210	1463	2267			**4940**
21:01	1210	1467	2216			**4893**
21:02	1210	1473	2250			**4933**
21:03	1210	1472	2280			**4961**
21:04	1210	1474	2269			**4952**
21:05	1210	1468	2272			**4951**
21:06	1210	1473	2274			**4956**
21:07	1210	1476	2275			**4960**

Nuclear Generation (MW) - 5 Apr 2020						
Time	**NR**	**WR**	**SR**	**ER**	**NER**	**All India**
21:08	1210	1474	2272			**4956**
21:09	1210	1472	2280			**4962**
21:10	1210	1480	2291			**4981**
21:11	1210	1476	2305			**4991**
21:12	1210	1475	2272			**4957**
21:13	1210	1477	2277			**4964**
21:14	1210	1472	2271			**4954**
21:15	1210	1476	2282			**4968**
21:16	1210	1468	2259			**4937**
21:17	1210	1476	2268			**4954**
21:18	1210	1467	2275			**4952**
21:19	1210	1474	2240			**4924**
21:20	1210	1469	2249			**4928**
21:21	1210	1467	2255			**4932**
21:22	1210	1468	2260			**4938**
21:23	1210	1472	2267			**4949**
21:24	1210	1469	2279			**4958**
21:25	1210	1478	2271			**4960**
21:26	1210	1470	2272			**4952**
21:27	1210	1472	2269			**4951**
21:28	1210	1476	2267			**4953**
21:29	1210	1467	2262			**4939**
21:30	1210	1474	2259			**4942**

Annexure 10.1 One Second Frequency Data

Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)
20:30:00	50.016	20:40:00	49.828	20:50:00	49.725	21:00:00	50.099	21:10:00	50.175	21:20:00	50.171
20:30:01	50.015	20:40:01	49.829	20:50:01	49.725	21:00:01	50.102	21:10:01	50.172	21:20:01	50.172
20:30:02	50.016	20:40:02	49.830	20:50:02	49.727	21:00:02	50.106	21:10:02	50.170	21:20:02	50.171
20:30:03	50.015	20:40:03	49.832	20:50:03	49.727	21:00:03	50.113	21:10:03	50.168	21:20:03	50.172
20:30:04	50.015	20:40:04	49.832	20:50:04	49.727	21:00:04	50.118	21:10:04	50.166	21:20:04	50.173
20:30:05	50.014	20:40:05	49.833	20:50:05	49.728	21:00:05	50.124	21:10:05	50.164	21:20:05	50.174
20:30:06	50.012	20:40:06	49.832	20:50:06	49.730	21:00:06	50.131	21:10:06	50.163	21:20:06	50.175
20:30:07	50.010	20:40:07	49.832	20:50:07	49.728	21:00:07	50.136	21:10:07	50.161	21:20:07	50.177
20:30:08	50.009	20:40:08	49.832	20:50:08	49.730	21:00:08	50.142	21:10:08	50.159	21:20:08	50.180
20:30:09	50.007	20:40:09	49.830	20:50:09	49.730	21:00:09	50.146	21:10:09	50.156	21:20:09	50.181
20:30:10	50.008	20:40:10	49.831	20:50:10	49.730	21:00:10	50.148	21:10:10	50.156	21:20:10	50.183
20:30:11	50.007	20:40:11	49.831	20:50:11	49.731	21:00:11	50.150	21:10:11	50.152	21:20:11	50.185
20:30:12	50.005	20:40:12	49.832	20:50:12	49.731	21:00:12	50.152	21:10:12	50.151	21:20:12	50.185
20:30:13	50.005	20:40:13	49.833	20:50:13	49.732	21:00:13	50.152	21:10:13	50.150	21:20:13	50.185
20:30:14	50.005	20:40:14	49.835	20:50:14	49.733	21:00:14	50.154	21:10:14	50.148	21:20:14	50.187
20:30:15	50.005	20:40:15	49.836	20:50:15	49.734	21:00:15	50.154	21:10:15	50.149	21:20:15	50.186
20:30:16	50.005	20:40:16	49.838	20:50:16	49.736	21:00:16	50.155	21:10:16	50.150	21:20:16	50.188
20:30:17	50.004	20:40:17	49.839	20:50:17	49.737	21:00:17	50.156	21:10:17	50.149	21:20:17	50.188
20:30:18	50.003	20:40:18	49.842	20:50:18	49.737	21:00:18	50.159	21:10:18	50.148	21:20:18	50.187
20:30:19	50.003	20:40:19	49.842	20:50:19	49.738	21:00:19	50.160	21:10:19	50.146	21:20:19	50.188
20:30:20	50.004	20:40:20	49.845	20:50:20	49.739	21:00:20	50.163	21:10:20	50.148	21:20:20	50.188
20:30:21	50.004	20:40:21	49.845	20:50:21	49.740	21:00:21	50.165	21:10:21	50.145	21:20:21	50.188
20:30:22	50.002	20:40:22	49.842	20:50:22	49.742	21:00:22	50.168	21:10:22	50.144	21:20:22	50.188
20:30:23	49.999	20:40:23	49.842	20:50:23	49.743	21:00:23	50.168	21:10:23	50.143	21:20:23	50.188
20:30:24	49.998	20:40:24	49.843	20:50:24	49.746	21:00:24	50.171	21:10:24	50.141	21:20:24	50.187
20:30:25	49.997	20:40:25	49.842	20:50:25	49.745	21:00:25	50.168	21:10:25	50.138	21:20:25	50.189
20:30:26	49.995	20:40:26	49.839	20:50:26	49.746	21:00:26	50.169	21:10:26	50.136	21:20:26	50.188
20:30:27	49.996	20:40:27	49.839	20:50:27	49.747	21:00:27	50.168	21:10:27	50.136	21:20:27	50.188
20:30:28	49.994	20:40:28	49.840	20:50:28	49.748	21:00:28	50.166	21:10:28	50.136	21:20:28	50.187
20:30:29	49.994	20:40:29	49.839	20:50:29	49.748	21:00:29	50.165	21:10:29	50.134	21:20:29	50.185
20:30:30	49.993	20:40:30	49.838	20:50:30	49.747	21:00:30	50.163	21:10:30	50.134	21:20:30	50.186
20:30:31	49.994	20:40:31	49.838	20:50:31	49.747	21:00:31	50.162	21:10:31	50.132	21:20:31	50.184
20:30:32	49.993	20:40:32	49.839	20:50:32	49.746	21:00:32	50.161	21:10:32	50.133	21:20:32	50.186
20:30:33	49.993	20:40:33	49.840	20:50:33	49.747	21:00:33	50.160	21:10:33	50.131	21:20:33	50.185
20:30:34	49.993	20:40:34	49.839	20:50:34	49.748	21:00:34	50.160	21:10:34	50.131	21:20:34	50.187
20:30:35	49.992	20:40:35	49.840	20:50:35	49.749	21:00:35	50.160	21:10:35	50.131	21:20:35	50.186
20:30:36	49.993	20:40:36	49.841	20:50:36	49.750	21:00:36	50.162	21:10:36	50.130	21:20:36	50.187
20:30:37	49.993	20:40:37	49.840	20:50:37	49.751	21:00:37	50.162	21:10:37	50.129	21:20:37	50.187

Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)
20:30:38	49.992	20:40:38	49.840	20:50:38	49.752	21:00:38	50.164	21:10:38	50.130	21:20:38	50.188
20:30:39	49.993	20:40:39	49.841	20:50:39	49.752	21:00:39	50.167	21:10:39	50.129	21:20:39	50.187
20:30:40	49.993	20:40:40	49.842	20:50:40	49.751	21:00:40	50.168	21:10:40	50.130	21:20:40	50.189
20:30:41	49.993	20:40:41	49.842	20:50:41	49.753	21:00:41	50.169	21:10:41	50.129	21:20:41	50.191
20:30:42	49.993	20:40:42	49.843	20:50:42	49.753	21:00:42	50.171	21:10:42	50.132	21:20:42	50.192
20:30:43	49.993	20:40:43	49.842	20:50:43	49.754	21:00:43	50.172	21:10:43	50.133	21:20:43	50.192
20:30:44	49.992	20:40:44	49.841	20:50:44	49.755	21:00:44	50.174	21:10:44	50.133	21:20:44	50.194
20:30:45	49.992	20:40:45	49.841	20:50:45	49.755	21:00:45	50.175	21:10:45	50.135	21:20:45	50.194
20:30:46	49.990	20:40:46	49.841	20:50:46	49.755	21:00:46	50.176	21:10:46	50.133	21:20:46	50.194
20:30:47	49.990	20:40:47	49.839	20:50:47	49.756	21:00:47	50.177	21:10:47	50.133	21:20:47	50.195
20:30:48	49.989	20:40:48	49.839	20:50:48	49.757	21:00:48	50.180	21:10:48	50.133	21:20:48	50.195
20:30:49	49.988	20:40:49	49.838	20:50:49	49.757	21:00:49	50.182	21:10:49	50.132	21:20:49	50.195
20:30:50	49.987	20:40:50	49.838	20:50:50	49.759	21:00:50	50.184	21:10:50	50.133	21:20:50	50.195
20:30:51	49.985	20:40:51	49.837	20:50:51	49.759	21:00:51	50.187	21:10:51	50.133	21:20:51	50.196
20:30:52	49.984	20:40:52	49.836	20:50:52	49.760	21:00:52	50.189	21:10:52	50.132	21:20:52	50.195
20:30:53	49.983	20:40:53	49.836	20:50:53	49.762	21:00:53	50.191	21:10:53	50.129	21:20:53	50.196
20:30:54	49.981	20:40:54	49.836	20:50:54	49.762	21:00:54	50.194	21:10:54	50.129	21:20:54	50.197
20:30:55	49.980	20:40:55	49.835	20:50:55	49.764	21:00:55	50.196	21:10:55	50.128	21:20:55	50.196
20:30:56	49.979	20:40:56	49.834	20:50:56	49.767	21:00:56	50.199	21:10:56	50.129	21:20:56	50.198
20:30:57	49.978	20:40:57	49.834	20:50:57	49.767	21:00:57	50.201	21:10:57	50.130	21:20:57	50.199
20:30:58	49.977	20:40:58	49.833	20:50:58	49.769	21:00:58	50.198	21:10:58	50.130	21:20:58	50.200
20:30:59	49.977	20:40:59	49.831	20:50:59	49.769	21:00:59	50.198	21:10:59	50.136	21:20:59	50.201
20:31:00	49.975	20:41:00	49.830	20:51:00	49.770	21:01:00	50.196	21:11:00	50.137	21:21:00	50.201
20:31:01	49.974	20:41:01	49.828	20:51:01	49.774	21:01:01	50.197	21:11:01	50.141	21:21:01	50.200
20:31:02	49.973	20:41:02	49.829	20:51:02	49.774	21:01:02	50.195	21:11:02	50.146	21:21:02	50.200
20:31:03	49.971	20:41:03	49.828	20:51:03	49.775	21:01:03	50.196	21:11:03	50.150	21:21:03	50.199
20:31:04	49.969	20:41:04	49.827	20:51:04	49.778	21:01:04	50.196	21:11:04	50.153	21:21:04	50.199
20:31:05	49.968	20:41:05	49.827	20:51:05	49.780	21:01:05	50.198	21:11:05	50.158	21:21:05	50.198
20:31:06	49.966	20:41:06	49.828	20:51:06	49.780	21:01:06	50.197	21:11:06	50.161	21:21:06	50.198
20:31:07	49.964	20:41:07	49.829	20:51:07	49.781	21:01:07	50.199	21:11:07	50.163	21:21:07	50.198
20:31:08	49.963	20:41:08	49.827	20:51:08	49.782	21:01:08	50.199	21:11:08	50.167	21:21:08	50.197
20:31:09	49.962	20:41:09	49.829	20:51:09	49.783	21:01:09	50.200	21:11:09	50.170	21:21:09	50.197
20:31:10	49.961	20:41:10	49.829	20:51:10	49.784	21:01:10	50.200	21:11:10	50.172	21:21:10	50.197
20:31:11	49.959	20:41:11	49.829	20:51:11	49.784	21:01:11	50.202	21:11:11	50.173	21:21:11	50.195
20:31:12	49.959	20:41:12	49.828	20:51:12	49.785	21:01:12	50.201	21:11:12	50.175	21:21:12	50.195
20:31:13	49.957	20:41:13	49.828	20:51:13	49.785	21:01:13	50.202	21:11:13	50.176	21:21:13	50.193
20:31:14	49.958	20:41:14	49.827	20:51:14	49.786	21:01:14	50.202	21:11:14	50.177	21:21:14	50.192
20:31:15	49.958	20:41:15	49.826	20:51:15	49.788	21:01:15	50.202	21:11:15	50.177	21:21:15	50.192
20:31:16	49.961	20:41:16	49.826	20:51:16	49.787	21:01:16	50.203	21:11:16	50.175	21:21:16	50.192
20:31:17	49.959	20:41:17	49.827	20:51:17	49.790	21:01:17	50.204	21:11:17	50.175	21:21:17	50.191
20:31:18	49.959	20:41:18	49.827	20:51:18	49.791	21:01:18	50.204	21:11:18	50.174	21:21:18	50.192

Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)
20:31:19	49.963	20:41:19	49.826	20:51:19	49.793	21:01:19	50.205	21:11:19	50.173	21:21:19	50.191
20:31:20	49.962	20:41:20	49.827	20:51:20	49.794	21:01:20	50.205	21:11:20	50.172	21:21:20	50.192
20:31:21	49.963	20:41:21	49.828	20:51:21	49.797	21:01:21	50.206	21:11:21	50.171	21:21:21	50.193
20:31:22	49.964	20:41:22	49.827	20:51:22	49.798	21:01:22	50.207	21:11:22	50.170	21:21:22	50.193
20:31:23	49.963	20:41:23	49.826	20:51:23	49.799	21:01:23	50.208	21:11:23	50.169	21:21:23	50.193
20:31:24	49.962	20:41:24	49.826	20:51:24	49.800	21:01:24	50.207	21:11:24	50.168	21:21:24	50.192
20:31:25	49.963	20:41:25	49.826	20:51:25	49.802	21:01:25	50.209	21:11:25	50.165	21:21:25	50.192
20:31:26	49.962	20:41:26	49.826	20:51:26	49.802	21:01:26	50.209	21:11:26	50.165	21:21:26	50.190
20:31:27	49.963	20:41:27	49.827	20:51:27	49.803	21:01:27	50.211	21:11:27	50.162	21:21:27	50.190
20:31:28	49.959	20:41:28	49.827	20:51:28	49.803	21:01:28	50.211	21:11:28	50.162	21:21:28	50.187
20:31:29	49.961	20:41:29	49.828	20:51:29	49.803	21:01:29	50.212	21:11:29	50.159	21:21:29	50.187
20:31:30	49.959	20:41:30	49.828	20:51:30	49.805	21:01:30	50.213	21:11:30	50.157	21:21:30	50.186
20:31:31	49.961	20:41:31	49.828	20:51:31	49.806	21:01:31	50.216	21:11:31	50.155	21:21:31	50.185
20:31:32	49.959	20:41:32	49.829	20:51:32	49.808	21:01:32	50.217	21:11:32	50.153	21:21:32	50.187
20:31:33	49.960	20:41:33	49.829	20:51:33	49.810	21:01:33	50.217	21:11:33	50.151	21:21:33	50.188
20:31:34	49.958	20:41:34	49.830	20:51:34	49.812	21:01:34	50.216	21:11:34	50.150	21:21:34	50.188
20:31:35	49.958	20:41:35	49.828	20:51:35	49.815	21:01:35	50.217	21:11:35	50.147	21:21:35	50.187
20:31:36	49.957	20:41:36	49.829	20:51:36	49.816	21:01:36	50.218	21:11:36	50.146	21:21:36	50.187
20:31:37	49.956	20:41:37	49.829	20:51:37	49.818	21:01:37	50.219	21:11:37	50.142	21:21:37	50.185
20:31:38	49.956	20:41:38	49.828	20:51:38	49.821	21:01:38	50.217	21:11:38	50.140	21:21:38	50.186
20:31:39	49.955	20:41:39	49.827	20:51:39	49.823	21:01:39	50.219	21:11:39	50.137	21:21:39	50.185
20:31:40	49.953	20:41:40	49.829	20:51:40	49.823	21:01:40	50.217	21:11:40	50.134	21:21:40	50.184
20:31:41	49.953	20:41:41	49.829	20:51:41	49.825	21:01:41	50.215	21:11:41	50.133	21:21:41	50.184
20:31:42	49.952	20:41:42	49.830	20:51:42	49.826	21:01:42	50.214	21:11:42	50.133	21:21:42	50.182
20:31:43	49.950	20:41:43	49.830	20:51:43	49.828	21:01:43	50.213	21:11:43	50.130	21:21:43	50.181
20:31:44	49.949	20:41:44	49.834	20:51:44	49.829	21:01:44	50.213	21:11:44	50.129	21:21:44	50.182
20:31:45	49.947	20:41:45	49.836	20:51:45	49.829	21:01:45	50.213	21:11:45	50.127	21:21:45	50.181
20:31:46	49.945	20:41:46	49.837	20:51:46	49.831	21:01:46	50.211	21:11:46	50.125	21:21:46	50.180
20:31:47	49.943	20:41:47	49.837	20:51:47	49.831	21:01:47	50.210	21:11:47	50.124	21:21:47	50.181
20:31:48	49.942	20:41:48	49.838	20:51:48	49.832	21:01:48	50.208	21:11:48	50.124	21:21:48	50.181
20:31:49	49.939	20:41:49	49.839	20:51:49	49.833	21:01:49	50.206	21:11:49	50.123	21:21:49	50.180
20:31:50	49.937	20:41:50	49.839	20:51:50	49.833	21:01:50	50.205	21:11:50	50.122	21:21:50	50.179
20:31:51	49.935	20:41:51	49.838	20:51:51	49.833	21:01:51	50.204	21:11:51	50.123	21:21:51	50.178
20:31:52	49.935	20:41:52	49.838	20:51:52	49.834	21:01:52	50.202	21:11:52	50.124	21:21:52	50.178
20:31:53	49.933	20:41:53	49.839	20:51:53	49.835	21:01:53	50.203	21:11:53	50.124	21:21:53	50.178
20:31:54	49.931	20:41:54	49.838	20:51:54	49.835	21:01:54	50.202	21:11:54	50.124	21:21:54	50.177
20:31:55	49.930	20:41:55	49.837	20:51:55	49.834	21:01:55	50.202	21:11:55	50.125	21:21:55	50.174
20:31:56	49.929	20:41:56	49.837	20:51:56	49.834	21:01:56	50.201	21:11:56	50.124	21:21:56	50.173
20:31:57	49.927	20:41:57	49.837	20:51:57	49.837	21:01:57	50.199	21:11:57	50.124	21:21:57	50.172
20:31:58	49.927	20:41:58	49.835	20:51:58	49.837	21:01:58	50.197	21:11:58	50.123	21:21:58	50.171
20:31:59	49.924	20:41:59	49.833	20:51:59	49.838	21:01:59	50.195	21:11:59	50.122	21:21:59	50.171

Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)
20:32:00	49.924	20:42:00	49.832	20:52:00	49.840	21:02:00	50.193	21:12:00	50.122	21:22:00	50.170
20:32:01	49.924	20:42:01	49.830	20:52:01	49.842	21:02:01	50.192	21:12:01	50.121	21:22:01	50.169
20:32:02	49.923	20:42:02	49.829	20:52:02	49.842	21:02:02	50.189	21:12:02	50.121	21:22:02	50.168
20:32:03	49.922	20:42:03	49.827	20:52:03	49.842	21:02:03	50.188	21:12:03	50.120	21:22:03	50.167
20:32:04	49.922	20:42:04	49.825	20:52:04	49.841	21:02:04	50.185	21:12:04	50.120	21:22:04	50.166
20:32:05	49.923	20:42:05	49.826	20:52:05	49.840	21:02:05	50.185	21:12:05	50.120	21:22:05	50.167
20:32:06	49.922	20:42:06	49.826	20:52:06	49.840	21:02:06	50.184	21:12:06	50.120	21:22:06	50.166
20:32:07	49.922	20:42:07	49.825	20:52:07	49.837	21:02:07	50.184	21:12:07	50.120	21:22:07	50.166
20:32:08	49.922	20:42:08	49.827	20:52:08	49.836	21:02:08	50.183	21:12:08	50.121	21:22:08	50.168
20:32:09	49.922	20:42:09	49.829	20:52:09	49.835	21:02:09	50.183	21:12:09	50.121	21:22:09	50.168
20:32:10	49.923	20:42:10	49.830	20:52:10	49.835	21:02:10	50.183	21:12:10	50.120	21:22:10	50.168
20:32:11	49.923	20:42:11	49.830	20:52:11	49.834	21:02:11	50.183	21:12:11	50.121	21:22:11	50.168
20:32:12	49.922	20:42:12	49.831	20:52:12	49.833	21:02:12	50.183	21:12:12	50.120	21:22:12	50.168
20:32:13	49.920	20:42:13	49.832	20:52:13	49.836	21:02:13	50.182	21:12:13	50.119	21:22:13	50.168
20:32:14	49.919	20:42:14	49.832	20:52:14	49.836	21:02:14	50.184	21:12:14	50.117	21:22:14	50.168
20:32:15	49.916	20:42:15	49.830	20:52:15	49.837	21:02:15	50.183	21:12:15	50.118	21:22:15	50.168
20:32:16	49.914	20:42:16	49.832	20:52:16	49.838	21:02:16	50.186	21:12:16	50.117	21:22:16	50.167
20:32:17	49.912	20:42:17	49.832	20:52:17	49.839	21:02:17	50.186	21:12:17	50.116	21:22:17	50.167
20:32:18	49.910	20:42:18	49.832	20:52:18	49.841	21:02:18	50.187	21:12:18	50.115	21:22:18	50.167
20:32:19	49.908	20:42:19	49.830	20:52:19	49.843	21:02:19	50.188	21:12:19	50.115	21:22:19	50.167
20:32:20	49.907	20:42:20	49.831	20:52:20	49.846	21:02:20	50.189	21:12:20	50.114	21:22:20	50.167
20:32:21	49.907	20:42:21	49.832	20:52:21	49.849	21:02:21	50.190	21:12:21	50.115	21:22:21	50.167
20:32:22	49.906	20:42:22	49.831	20:52:22	49.853	21:02:22	50.189	21:12:22	50.114	21:22:22	50.168
20:32:23	49.906	20:42:23	49.831	20:52:23	49.855	21:02:23	50.188	21:12:23	50.113	21:22:23	50.167
20:32:24	49.906	20:42:24	49.832	20:52:24	49.857	21:02:24	50.186	21:12:24	50.114	21:22:24	50.167
20:32:25	49.904	20:42:25	49.833	20:52:25	49.860	21:02:25	50.186	21:12:25	50.113	21:22:25	50.166
20:32:26	49.905	20:42:26	49.833	20:52:26	49.862	21:02:26	50.183	21:12:26	50.114	21:22:26	50.166
20:32:27	49.904	20:42:27	49.833	20:52:27	49.864	21:02:27	50.184	21:12:27	50.114	21:22:27	50.167
20:32:28	49.905	20:42:28	49.833	20:52:28	49.865	21:02:28	50.185	21:12:28	50.116	21:22:28	50.166
20:32:29	49.903	20:42:29	49.834	20:52:29	49.866	21:02:29	50.185	21:12:29	50.117	21:22:29	50.165
20:32:30	49.907	20:42:30	49.834	20:52:30	49.866	21:02:30	50.185	21:12:30	50.118	21:22:30	50.165
20:32:31	49.906	20:42:31	49.833	20:52:31	49.866	21:02:31	50.185	21:12:31	50.119	21:22:31	50.166
20:32:32	49.907	20:42:32	49.834	20:52:32	49.868	21:02:32	50.187	21:12:32	50.121	21:22:32	50.166
20:32:33	49.907	20:42:33	49.834	20:52:33	49.870	21:02:33	50.188	21:12:33	50.121	21:22:33	50.166
20:32:34	49.906	20:42:34	49.834	20:52:34	49.871	21:02:34	50.189	21:12:34	50.122	21:22:34	50.166
20:32:35	49.904	20:42:35	49.833	20:52:35	49.872	21:02:35	50.189	21:12:35	50.124	21:22:35	50.166
20:32:36	49.904	20:42:36	49.833	20:52:36	49.873	21:02:36	50.190	21:12:36	50.125	21:22:36	50.167
20:32:37	49.902	20:42:37	49.834	20:52:37	49.875	21:02:37	50.192	21:12:37	50.126	21:22:37	50.168
20:32:38	49.902	20:42:38	49.834	20:52:38	49.877	21:02:38	50.193	21:12:38	50.127	21:22:38	50.169
20:32:39	49.903	20:42:39	49.833	20:52:39	49.878	21:02:39	50.194	21:12:39	50.127	21:22:39	50.170
20:32:40	49.902	20:42:40	49.834	20:52:40	49.880	21:02:40	50.195	21:12:40	50.130	21:22:40	50.170

Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)
20:32:41	49.904	20:42:41	49.835	20:52:41	49.882	21:02:41	50.195	21:12:41	50.130	21:22:41	50.171
20:32:42	49.903	20:42:42	49.835	20:52:42	49.884	21:02:42	50.196	21:12:42	50.132	21:22:42	50.171
20:32:43	49.904	20:42:43	49.834	20:52:43	49.885	21:02:43	50.197	21:12:43	50.132	21:22:43	50.172
20:32:44	49.904	20:42:44	49.835	20:52:44	49.889	21:02:44	50.198	21:12:44	50.134	21:22:44	50.172
20:32:45	49.905	20:42:45	49.837	20:52:45	49.890	21:02:45	50.198	21:12:45	50.137	21:22:45	50.172
20:32:46	49.905	20:42:46	49.836	20:52:46	49.893	21:02:46	50.200	21:12:46	50.137	21:22:46	50.172
20:32:47	49.903	20:42:47	49.836	20:52:47	49.893	21:02:47	50.199	21:12:47	50.137	21:22:47	50.171
20:32:48	49.903	20:42:48	49.837	20:52:48	49.894	21:02:48	50.200	21:12:48	50.139	21:22:48	50.172
20:32:49	49.904	20:42:49	49.837	20:52:49	49.895	21:02:49	50.200	21:12:49	50.143	21:22:49	50.172
20:32:50	49.906	20:42:50	49.836	20:52:50	49.897	21:02:50	50.201	21:12:50	50.142	21:22:50	50.171
20:32:51	49.906	20:42:51	49.836	20:52:51	49.900	21:02:51	50.200	21:12:51	50.146	21:22:51	50.172
20:32:52	49.906	20:42:52	49.836	20:52:52	49.901	21:02:52	50.203	21:12:52	50.148	21:22:52	50.173
20:32:53	49.906	20:42:53	49.836	20:52:53	49.904	21:02:53	50.202	21:12:53	50.151	21:22:53	50.175
20:32:54	49.904	20:42:54	49.838	20:52:54	49.908	21:02:54	50.203	21:12:54	50.154	21:22:54	50.176
20:32:55	49.903	20:42:55	49.837	20:52:55	49.913	21:02:55	50.206	21:12:55	50.155	21:22:55	50.177
20:32:56	49.902	20:42:56	49.838	20:52:56	49.917	21:02:56	50.207	21:12:56	50.158	21:22:56	50.178
20:32:57	49.900	20:42:57	49.838	20:52:57	49.921	21:02:57	50.208	21:12:57	50.158	21:22:57	50.176
20:32:58	49.898	20:42:58	49.839	20:52:58	49.924	21:02:58	50.210	21:12:58	50.159	21:22:58	50.176
20:32:59	49.898	20:42:59	49.840	20:52:59	49.928	21:02:59	50.210	21:12:59	50.160	21:22:59	50.175
20:33:00	49.897	20:43:00	49.840	20:53:00	49.931	21:03:00	50.210	21:13:00	50.159	21:23:00	50.174
20:33:01	49.896	20:43:01	49.841	20:53:01	49.933	21:03:01	50.210	21:13:01	50.160	21:23:01	50.174
20:33:02	49.897	20:43:02	49.842	20:53:02	49.936	21:03:02	50.209	21:13:02	50.160	21:23:02	50.174
20:33:03	49.895	20:43:03	49.842	20:53:03	49.936	21:03:03	50.209	21:13:03	50.158	21:23:03	50.172
20:33:04	49.894	20:43:04	49.841	20:53:04	49.939	21:03:04	50.206	21:13:04	50.158	21:23:04	50.171
20:33:05	49.893	20:43:05	49.843	20:53:05	49.940	21:03:05	50.205	21:13:05	50.156	21:23:05	50.169
20:33:06	49.893	20:43:06	49.843	20:53:06	49.941	21:03:06	50.204	21:13:06	50.156	21:23:06	50.170
20:33:07	49.891	20:43:07	49.843	20:53:07	49.943	21:03:07	50.205	21:13:07	50.155	21:23:07	50.168
20:33:08	49.891	20:43:08	49.843	20:53:08	49.943	21:03:08	50.205	21:13:08	50.155	21:23:08	50.167
20:33:09	49.891	20:43:09	49.843	20:53:09	49.945	21:03:09	50.204	21:13:09	50.154	21:23:09	50.166
20:33:10	49.891	20:43:10	49.844	20:53:10	49.944	21:03:10	50.204	21:13:10	50.152	21:23:10	50.164
20:33:11	49.890	20:43:11	49.844	20:53:11	49.945	21:03:11	50.204	21:13:11	50.151	21:23:11	50.165
20:33:12	49.888	20:43:12	49.843	20:53:12	49.945	21:03:12	50.204	21:13:12	50.150	21:23:12	50.166
20:33:13	49.886	20:43:13	49.842	20:53:13	49.945	21:03:13	50.206	21:13:13	50.147	21:23:13	50.168
20:33:14	49.887	20:43:14	49.842	20:53:14	49.944	21:03:14	50.207	21:13:14	50.147	21:23:14	50.168
20:33:15	49.887	20:43:15	49.842	20:53:15	49.945	21:03:15	50.207	21:13:15	50.145	21:23:15	50.170
20:33:16	49.888	20:43:16	49.841	20:53:16	49.944	21:03:16	50.206	21:13:16	50.144	21:23:16	50.169
20:33:17	49.888	20:43:17	49.840	20:53:17	49.943	21:03:17	50.206	21:13:17	50.140	21:23:17	50.168
20:33:18	49.886	20:43:18	49.839	20:53:18	49.946	21:03:18	50.205	21:13:18	50.139	21:23:18	50.167
20:33:19	49.883	20:43:19	49.840	20:53:19	49.948	21:03:19	50.206	21:13:19	50.138	21:23:19	50.166
20:33:20	49.883	20:43:20	49.840	20:53:20	49.948	21:03:20	50.207	21:13:20	50.137	21:23:20	50.164
20:33:21	49.882	20:43:21	49.839	20:53:21	49.949	21:03:21	50.206	21:13:21	50.136	21:23:21	50.164

Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)
20:33:22	49.881	20:43:22	49.838	20:53:22	49.951	21:03:22	50.206	21:13:22	50.135	21:23:22	50.161
20:33:23	49.881	20:43:23	49.837	20:53:23	49.953	21:03:23	50.206	21:13:23	50.134	21:23:23	50.163
20:33:24	49.882	20:43:24	49.837	20:53:24	49.953	21:03:24	50.205	21:13:24	50.133	21:23:24	50.162
20:33:25	49.882	20:43:25	49.836	20:53:25	49.955	21:03:25	50.205	21:13:25	50.133	21:23:25	50.162
20:33:26	49.881	20:43:26	49.836	20:53:26	49.954	21:03:26	50.205	21:13:26	50.132	21:23:26	50.163
20:33:27	49.880	20:43:27	49.838	20:53:27	49.954	21:03:27	50.205	21:13:27	50.131	21:23:27	50.162
20:33:28	49.880	20:43:28	49.839	20:53:28	49.954	21:03:28	50.204	21:13:28	50.130	21:23:28	50.161
20:33:29	49.883	20:43:29	49.840	20:53:29	49.955	21:03:29	50.204	21:13:29	50.128	21:23:29	50.160
20:33:30	49.884	20:43:30	49.841	20:53:30	49.954	21:03:30	50.203	21:13:30	50.126	21:23:30	50.161
20:33:31	49.885	20:43:31	49.841	20:53:31	49.952	21:03:31	50.202	21:13:31	50.125	21:23:31	50.160
20:33:32	49.884	20:43:32	49.845	20:53:32	49.952	21:03:32	50.201	21:13:32	50.122	21:23:32	50.160
20:33:33	49.882	20:43:33	49.844	20:53:33	49.952	21:03:33	50.202	21:13:33	50.122	21:23:33	50.160
20:33:34	49.881	20:43:34	49.845	20:53:34	49.953	21:03:34	50.201	21:13:34	50.121	21:23:34	50.159
20:33:35	49.879	20:43:35	49.846	20:53:35	49.953	21:03:35	50.202	21:13:35	50.121	21:23:35	50.161
20:33:36	49.878	20:43:36	49.848	20:53:36	49.955	21:03:36	50.201	21:13:36	50.121	21:23:36	50.162
20:33:37	49.876	20:43:37	49.848	20:53:37	49.955	21:03:37	50.201	21:13:37	50.121	21:23:37	50.161
20:33:38	49.876	20:43:38	49.848	20:53:38	49.955	21:03:38	50.201	21:13:38	50.122	21:23:38	50.163
20:33:39	49.874	20:43:39	49.848	20:53:39	49.956	21:03:39	50.201	21:13:39	50.123	21:23:39	50.163
20:33:40	49.871	20:43:40	49.850	20:53:40	49.957	21:03:40	50.200	21:13:40	50.125	21:23:40	50.162
20:33:41	49.870	20:43:41	49.852	20:53:41	49.956	21:03:41	50.200	21:13:41	50.125	21:23:41	50.161
20:33:42	49.871	20:43:42	49.853	20:53:42	49.956	21:03:42	50.199	21:13:42	50.126	21:23:42	50.161
20:33:43	49.872	20:43:43	49.853	20:53:43	49.956	21:03:43	50.200	21:13:43	50.126	21:23:43	50.160
20:33:44	49.871	20:43:44	49.854	20:53:44	49.956	21:03:44	50.199	21:13:44	50.129	21:23:44	50.159
20:33:45	49.872	20:43:45	49.855	20:53:45	49.955	21:03:45	50.200	21:13:45	50.131	21:23:45	50.159
20:33:46	49.870	20:43:46	49.857	20:53:46	49.955	21:03:46	50.200	21:13:46	50.133	21:23:46	50.158
20:33:47	49.871	20:43:47	49.857	20:53:47	49.955	21:03:47	50.202	21:13:47	50.133	21:23:47	50.159
20:33:48	49.872	20:43:48	49.858	20:53:48	49.954	21:03:48	50.203	21:13:48	50.134	21:23:48	50.162
20:33:49	49.872	20:43:49	49.859	20:53:49	49.952	21:03:49	50.203	21:13:49	50.135	21:23:49	50.162
20:33:50	49.871	20:43:50	49.859	20:53:50	49.951	21:03:50	50.203	21:13:50	50.134	21:23:50	50.166
20:33:51	49.869	20:43:51	49.860	20:53:51	49.951	21:03:51	50.203	21:13:51	50.133	21:23:51	50.167
20:33:52	49.869	20:43:52	49.860	20:53:52	49.950	21:03:52	50.204	21:13:52	50.133	21:23:52	50.168
20:33:53	49.867	20:43:53	49.860	20:53:53	49.951	21:03:53	50.204	21:13:53	50.131	21:23:53	50.169
20:33:54	49.867	20:43:54	49.861	20:53:54	49.950	21:03:54	50.203	21:13:54	50.129	21:23:54	50.169
20:33:55	49.867	20:43:55	49.862	20:53:55	49.950	21:03:55	50.203	21:13:55	50.130	21:23:55	50.170
20:33:56	49.868	20:43:56	49.862	20:53:56	49.948	21:03:56	50.205	21:13:56	50.131	21:23:56	50.169
20:33:57	49.868	20:43:57	49.863	20:53:57	49.946	21:03:57	50.205	21:13:57	50.132	21:23:57	50.170
20:33:58	49.868	20:43:58	49.862	20:53:58	49.944	21:03:58	50.205	21:13:58	50.133	21:23:58	50.171
20:33:59	49.871	20:43:59	49.862	20:53:59	49.943	21:03:59	50.205	21:13:59	50.132	21:23:59	50.172
20:34:00	49.874	20:44:00	49.862	20:54:00	49.941	21:04:00	50.206	21:14:00	50.131	21:24:00	50.173
20:34:01	49.875	20:44:01	49.863	20:54:01	49.939	21:04:01	50.207	21:14:01	50.130	21:24:01	50.171
20:34:02	49.875	20:44:02	49.862	20:54:02	49.939	21:04:02	50.208	21:14:02	50.129	21:24:02	50.173

Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)
20:34:03	49.874	20:44:03	49.862	20:54:03	49.938	21:04:03	50.209	21:14:03	50.128	21:24:03	50.171
20:34:04	49.874	20:44:04	49.863	20:54:04	49.937	21:04:04	50.210	21:14:04	50.126	21:24:04	50.172
20:34:05	49.873	20:44:05	49.863	20:54:05	49.937	21:04:05	50.211	21:14:05	50.127	21:24:05	50.171
20:34:06	49.871	20:44:06	49.863	20:54:06	49.937	21:04:06	50.213	21:14:06	50.126	21:24:06	50.173
20:34:07	49.870	20:44:07	49.863	20:54:07	49.936	21:04:07	50.215	21:14:07	50.125	21:24:07	50.172
20:34:08	49.869	20:44:08	49.861	20:54:08	49.937	21:04:08	50.216	21:14:08	50.124	21:24:08	50.171
20:34:09	49.868	20:44:09	49.860	20:54:09	49.937	21:04:09	50.219	21:14:09	50.124	21:24:09	50.171
20:34:10	49.867	20:44:10	49.860	20:54:10	49.936	21:04:10	50.219	21:14:10	50.123	21:24:10	50.169
20:34:11	49.867	20:44:11	49.860	20:54:11	49.935	21:04:11	50.220	21:14:11	50.122	21:24:11	50.168
20:34:12	49.868	20:44:12	49.860	20:54:12	49.935	21:04:12	50.220	21:14:12	50.124	21:24:12	50.167
20:34:13	49.868	20:44:13	49.858	20:54:13	49.936	21:04:13	50.222	21:14:13	50.122	21:24:13	50.166
20:34:14	49.868	20:44:14	49.856	20:54:14	49.934	21:04:14	50.223	21:14:14	50.121	21:24:14	50.166
20:34:15	49.867	20:44:15	49.856	20:54:15	49.934	21:04:15	50.223	21:14:15	50.121	21:24:15	50.163
20:34:16	49.866	20:44:16	49.856	20:54:16	49.932	21:04:16	50.224	21:14:16	50.120	21:24:16	50.165
20:34:17	49.868	20:44:17	49.855	20:54:17	49.932	21:04:17	50.224	21:14:17	50.118	21:24:17	50.164
20:34:18	49.867	20:44:18	49.854	20:54:18	49.930	21:04:18	50.224	21:14:18	50.117	21:24:18	50.165
20:34:19	49.867	20:44:19	49.853	20:54:19	49.930	21:04:19	50.224	21:14:19	50.115	21:24:19	50.166
20:34:20	49.866	20:44:20	49.852	20:54:20	49.929	21:04:20	50.226	21:14:20	50.115	21:24:20	50.165
20:34:21	49.867	20:44:21	49.853	20:54:21	49.927	21:04:21	50.225	21:14:21	50.115	21:24:21	50.166
20:34:22	49.866	20:44:22	49.852	20:54:22	49.925	21:04:22	50.226	21:14:22	50.114	21:24:22	50.166
20:34:23	49.865	20:44:23	49.851	20:54:23	49.923	21:04:23	50.225	21:14:23	50.113	21:24:23	50.167
20:34:24	49.866	20:44:24	49.851	20:54:24	49.923	21:04:24	50.226	21:14:24	50.114	21:24:24	50.167
20:34:25	49.867	20:44:25	49.851	20:54:25	49.921	21:04:25	50.228	21:14:25	50.114	21:24:25	50.165
20:34:26	49.866	20:44:26	49.852	20:54:26	49.920	21:04:26	50.230	21:14:26	50.113	21:24:26	50.165
20:34:27	49.866	20:44:27	49.853	20:54:27	49.920	21:04:27	50.228	21:14:27	50.113	21:24:27	50.163
20:34:28	49.865	20:44:28	49.852	20:54:28	49.919	21:04:28	50.230	21:14:28	50.116	21:24:28	50.163
20:34:29	49.864	20:44:29	49.853	20:54:29	49.920	21:04:29	50.231	21:14:29	50.116	21:24:29	50.161
20:34:30	49.864	20:44:30	49.853	20:54:30	49.920	21:04:30	50.231	21:14:30	50.119	21:24:30	50.161
20:34:31	49.863	20:44:31	49.852	20:54:31	49.920	21:04:31	50.231	21:14:31	50.122	21:24:31	50.161
20:34:32	49.863	20:44:32	49.852	20:54:32	49.922	21:04:32	50.230	21:14:32	50.123	21:24:32	50.161
20:34:33	49.861	20:44:33	49.851	20:54:33	49.924	21:04:33	50.232	21:14:33	50.122	21:24:33	50.161
20:34:34	49.861	20:44:34	49.850	20:54:34	49.925	21:04:34	50.232	21:14:34	50.123	21:24:34	50.160
20:34:35	49.860	20:44:35	49.848	20:54:35	49.926	21:04:35	50.232	21:14:35	50.122	21:24:35	50.161
20:34:36	49.862	20:44:36	49.848	20:54:36	49.927	21:04:36	50.232	21:14:36	50.123	21:24:36	50.161
20:34:37	49.861	20:44:37	49.847	20:54:37	49.928	21:04:37	50.231	21:14:37	50.127	21:24:37	50.160
20:34:38	49.860	20:44:38	49.846	20:54:38	49.929	21:04:38	50.231	21:14:38	50.124	21:24:38	50.162
20:34:39	49.862	20:44:39	49.844	20:54:39	49.930	21:04:39	50.231	21:14:39	50.125	21:24:39	50.161
20:34:40	49.862	20:44:40	49.844	20:54:40	49.931	21:04:40	50.230	21:14:40	50.127	21:24:40	50.162
20:34:41	49.863	20:44:41	49.843	20:54:41	49.930	21:04:41	50.229	21:14:41	50.126	21:24:41	50.163
20:34:42	49.863	20:44:42	49.843	20:54:42	49.932	21:04:42	50.227	21:14:42	50.128	21:24:42	50.163
20:34:43	49.863	20:44:43	49.842	20:54:43	49.932	21:04:43	50.227	21:14:43	50.130	21:24:43	50.163

Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)
20:34:44	49.861	20:44:44	49.843	20:54:44	49.933	21:04:44	50.227	21:14:44	50.131	21:24:44	50.160
20:34:45	49.860	20:44:45	49.843	20:54:45	49.932	21:04:45	50.226	21:14:45	50.132	21:24:45	50.160
20:34:46	49.859	20:44:46	49.841	20:54:46	49.932	21:04:46	50.226	21:14:46	50.136	21:24:46	50.158
20:34:47	49.859	20:44:47	49.839	20:54:47	49.932	21:04:47	50.224	21:14:47	50.136	21:24:47	50.157
20:34:48	49.858	20:44:48	49.837	20:54:48	49.932	21:04:48	50.226	21:14:48	50.138	21:24:48	50.158
20:34:49	49.858	20:44:49	49.835	20:54:49	49.933	21:04:49	50.225	21:14:49	50.141	21:24:49	50.155
20:34:50	49.856	20:44:50	49.833	20:54:50	49.933	21:04:50	50.225	21:14:50	50.139	21:24:50	50.155
20:34:51	49.857	20:44:51	49.831	20:54:51	49.933	21:04:51	50.225	21:14:51	50.144	21:24:51	50.154
20:34:52	49.860	20:44:52	49.829	20:54:52	49.934	21:04:52	50.225	21:14:52	50.143	21:24:52	50.153
20:34:53	49.859	20:44:53	49.827	20:54:53	49.935	21:04:53	50.224	21:14:53	50.143	21:24:53	50.153
20:34:54	49.858	20:44:54	49.825	20:54:54	49.935	21:04:54	50.223	21:14:54	50.145	21:24:54	50.151
20:34:55	49.859	20:44:55	49.823	20:54:55	49.936	21:04:55	50.225	21:14:55	50.146	21:24:55	50.150
20:34:56	49.860	20:44:56	49.823	20:54:56	49.937	21:04:56	50.226	21:14:56	50.147	21:24:56	50.148
20:34:57	49.861	20:44:57	49.821	20:54:57	49.937	21:04:57	50.226	21:14:57	50.148	21:24:57	50.147
20:34:58	49.864	20:44:58	49.818	20:54:58	49.936	21:04:58	50.225	21:14:58	50.147	21:24:58	50.149
20:34:59	49.862	20:44:59	49.818	20:54:59	49.936	21:04:59	50.227	21:14:59	50.149	21:24:59	50.147
20:35:00	49.863	20:45:00	49.817	20:55:00	49.936	21:05:00	50.226	21:15:00	50.150	21:25:00	50.148
20:35:01	49.863	20:45:01	49.815	20:55:01	49.936	21:05:01	50.227	21:15:01	50.149	21:25:01	50.148
20:35:02	49.865	20:45:02	49.814	20:55:02	49.936	21:05:02	50.225	21:15:02	50.150	21:25:02	50.148
20:35:03	49.866	20:45:03	49.812	20:55:03	49.937	21:05:03	50.226	21:15:03	50.149	21:25:03	50.149
20:35:04	49.869	20:45:04	49.813	20:55:04	49.937	21:05:04	50.226	21:15:04	50.152	21:25:04	50.150
20:35:05	49.867	20:45:05	49.811	20:55:05	49.937	21:05:05	50.226	21:15:05	50.150	21:25:05	50.150
20:35:06	49.869	20:45:06	49.811	20:55:06	49.936	21:05:06	50.224	21:15:06	50.150	21:25:06	50.149
20:35:07	49.871	20:45:07	49.810	20:55:07	49.938	21:05:07	50.224	21:15:07	50.150	21:25:07	50.149
20:35:08	49.874	20:45:08	49.811	20:55:08	49.938	21:05:08	50.222	21:15:08	50.148	21:25:08	50.150
20:35:09	49.875	20:45:09	49.809	20:55:09	49.939	21:05:09	50.223	21:15:09	50.149	21:25:09	50.151
20:35:10	49.875	20:45:10	49.810	20:55:10	49.939	21:05:10	50.220	21:15:10	50.148	21:25:10	50.152
20:35:11	49.875	20:45:11	49.811	20:55:11	49.939	21:05:11	50.221	21:15:11	50.147	21:25:11	50.153
20:35:12	49.874	20:45:12	49.810	20:55:12	49.941	21:05:12	50.221	21:15:12	50.148	21:25:12	50.155
20:35:13	49.875	20:45:13	49.811	20:55:13	49.941	21:05:13	50.222	21:15:13	50.145	21:25:13	50.157
20:35:14	49.875	20:45:14	49.813	20:55:14	49.943	21:05:14	50.220	21:15:14	50.142	21:25:14	50.157
20:35:15	49.877	20:45:15	49.813	20:55:15	49.943	21:05:15	50.220	21:15:15	50.142	21:25:15	50.157
20:35:16	49.875	20:45:16	49.814	20:55:16	49.945	21:05:16	50.220	21:15:16	50.140	21:25:16	50.160
20:35:17	49.874	20:45:17	49.816	20:55:17	49.945	21:05:17	50.219	21:15:17	50.139	21:25:17	50.160
20:35:18	49.873	20:45:18	49.817	20:55:18	49.946	21:05:18	50.220	21:15:18	50.139	21:25:18	50.161
20:35:19	49.874	20:45:19	49.817	20:55:19	49.948	21:05:19	50.219	21:15:19	50.137	21:25:19	50.160
20:35:20	49.874	20:45:20	49.819	20:55:20	49.949	21:05:20	50.220	21:15:20	50.139	21:25:20	50.160
20:35:21	49.875	20:45:21	49.821	20:55:21	49.948	21:05:21	50.220	21:15:21	50.139	21:25:21	50.160
20:35:22	49.875	20:45:22	49.822	20:55:22	49.948	21:05:22	50.220	21:15:22	50.137	21:25:22	50.159
20:35:23	49.875	20:45:23	49.822	20:55:23	49.948	21:05:23	50.221	21:15:23	50.138	21:25:23	50.159
20:35:24	49.876	20:45:24	49.824	20:55:24	49.950	21:05:24	50.220	21:15:24	50.137	21:25:24	50.159

Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)
20:35:25	49.876	20:45:25	49.825	20:55:25	49.950	21:05:25	50.220	21:15:25	50.139	21:25:25	50.160
20:35:26	49.878	20:45:26	49.826	20:55:26	49.949	21:05:26	50.220	21:15:26	50.140	21:25:26	50.160
20:35:27	49.878	20:45:27	49.825	20:55:27	49.949	21:05:27	50.219	21:15:27	50.143	21:25:27	50.159
20:35:28	49.880	20:45:28	49.827	20:55:28	49.949	21:05:28	50.220	21:15:28	50.142	21:25:28	50.160
20:35:29	49.879	20:45:29	49.828	20:55:29	49.950	21:05:29	50.219	21:15:29	50.146	21:25:29	50.159
20:35:30	49.878	20:45:30	49.827	20:55:30	49.952	21:05:30	50.218	21:15:30	50.146	21:25:30	50.159
20:35:31	49.878	20:45:31	49.828	20:55:31	49.953	21:05:31	50.218	21:15:31	50.147	21:25:31	50.158
20:35:32	49.878	20:45:32	49.830	20:55:32	49.951	21:05:32	50.217	21:15:32	50.148	21:25:32	50.158
20:35:33	49.880	20:45:33	49.832	20:55:33	49.953	21:05:33	50.218	21:15:33	50.147	21:25:33	50.157
20:35:34	49.881	20:45:34	49.833	20:55:34	49.953	21:05:34	50.217	21:15:34	50.147	21:25:34	50.158
20:35:35	49.880	20:45:35	49.832	20:55:35	49.953	21:05:35	50.216	21:15:35	50.145	21:25:35	50.157
20:35:36	49.880	20:45:36	49.833	20:55:36	49.951	21:05:36	50.218	21:15:36	50.146	21:25:36	50.158
20:35:37	49.879	20:45:37	49.834	20:55:37	49.952	21:05:37	50.216	21:15:37	50.145	21:25:37	50.156
20:35:38	49.879	20:45:38	49.834	20:55:38	49.949	21:05:38	50.216	21:15:38	50.143	21:25:38	50.156
20:35:39	49.879	20:45:39	49.832	20:55:39	49.950	21:05:39	50.217	21:15:39	50.143	21:25:39	50.155
20:35:40	49.881	20:45:40	49.833	20:55:40	49.951	21:05:40	50.216	21:15:40	50.139	21:25:40	50.154
20:35:41	49.880	20:45:41	49.834	20:55:41	49.950	21:05:41	50.217	21:15:41	50.140	21:25:41	50.153
20:35:42	49.879	20:45:42	49.834	20:55:42	49.950	21:05:42	50.216	21:15:42	50.141	21:25:42	50.153
20:35:43	49.880	20:45:43	49.834	20:55:43	49.951	21:05:43	50.218	21:15:43	50.138	21:25:43	50.151
20:35:44	49.880	20:45:44	49.837	20:55:44	49.954	21:05:44	50.218	21:15:44	50.140	21:25:44	50.150
20:35:45	49.880	20:45:45	49.836	20:55:45	49.953	21:05:45	50.219	21:15:45	50.139	21:25:45	50.149
20:35:46	49.880	20:45:46	49.837	20:55:46	49.954	21:05:46	50.219	21:15:46	50.140	21:25:46	50.150
20:35:47	49.882	20:45:47	49.836	20:55:47	49.956	21:05:47	50.219	21:15:47	50.142	21:25:47	50.149
20:35:48	49.881	20:45:48	49.837	20:55:48	49.957	21:05:48	50.218	21:15:48	50.142	21:25:48	50.148
20:35:49	49.881	20:45:49	49.837	20:55:49	49.958	21:05:49	50.219	21:15:49	50.143	21:25:49	50.149
20:35:50	49.881	20:45:50	49.835	20:55:50	49.960	21:05:50	50.218	21:15:50	50.146	21:25:50	50.148
20:35:51	49.880	20:45:51	49.834	20:55:51	49.962	21:05:51	50.217	21:15:51	50.146	21:25:51	50.149
20:35:52	49.881	20:45:52	49.833	20:55:52	49.965	21:05:52	50.217	21:15:52	50.148	21:25:52	50.148
20:35:53	49.880	20:45:53	49.833	20:55:53	49.965	21:05:53	50.216	21:15:53	50.148	21:25:53	50.149
20:35:54	49.882	20:45:54	49.830	20:55:54	49.966	21:05:54	50.215	21:15:54	50.148	21:25:54	50.150
20:35:55	49.881	20:45:55	49.828	20:55:55	49.967	21:05:55	50.215	21:15:55	50.146	21:25:55	50.148
20:35:56	49.881	20:45:56	49.828	20:55:56	49.969	21:05:56	50.215	21:15:56	50.147	21:25:56	50.148
20:35:57	49.878	20:45:57	49.829	20:55:57	49.969	21:05:57	50.215	21:15:57	50.147	21:25:57	50.148
20:35:58	49.879	20:45:58	49.827	20:55:58	49.971	21:05:58	50.215	21:15:58	50.147	21:25:58	50.149
20:35:59	49.878	20:45:59	49.827	20:55:59	49.970	21:05:59	50.214	21:15:59	50.145	21:25:59	50.152
20:36:00	49.879	20:46:00	49.828	20:56:00	49.971	21:06:00	50.213	21:16:00	50.144	21:26:00	50.152
20:36:01	49.878	20:46:01	49.829	20:56:01	49.970	21:06:01	50.214	21:16:01	50.145	21:26:01	50.153
20:36:02	49.877	20:46:02	49.829	20:56:02	49.968	21:06:02	50.214	21:16:02	50.143	21:26:02	50.152
20:36:03	49.876	20:46:03	49.829	20:56:03	49.967	21:06:03	50.214	21:16:03	50.142	21:26:03	50.152
20:36:04	49.875	20:46:04	49.831	20:56:04	49.968	21:06:04	50.217	21:16:04	50.143	21:26:04	50.153
20:36:05	49.876	20:46:05	49.831	20:56:05	49.966	21:06:05	50.217	21:16:05	50.143	21:26:05	50.151

Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)
20:36:06	49.875	20:46:06	49.830	20:56:06	49.965	21:06:06	50.217	21:16:06	50.143	21:26:06	50.150
20:36:07	49.875	20:46:07	49.830	20:56:07	49.966	21:06:07	50.218	21:16:07	50.143	21:26:07	50.150
20:36:08	49.873	20:46:08	49.831	20:56:08	49.967	21:06:08	50.219	21:16:08	50.144	21:26:08	50.147
20:36:09	49.872	20:46:09	49.831	20:56:09	49.968	21:06:09	50.220	21:16:09	50.144	21:26:09	50.148
20:36:10	49.868	20:46:10	49.829	20:56:10	49.966	21:06:10	50.219	21:16:10	50.143	21:26:10	50.147
20:36:11	49.869	20:46:11	49.830	20:56:11	49.966	21:06:11	50.219	21:16:11	50.144	21:26:11	50.146
20:36:12	49.868	20:46:12	49.831	20:56:12	49.965	21:06:12	50.219	21:16:12	50.143	21:26:12	50.146
20:36:13	49.868	20:46:13	49.830	20:56:13	49.965	21:06:13	50.217	21:16:13	50.141	21:26:13	50.144
20:36:14	49.868	20:46:14	49.829	20:56:14	49.965	21:06:14	50.216	21:16:14	50.139	21:26:14	50.144
20:36:15	49.868	20:46:15	49.828	20:56:15	49.964	21:06:15	50.216	21:16:15	50.136	21:26:15	50.145
20:36:16	49.866	20:46:16	49.826	20:56:16	49.964	21:06:16	50.217	21:16:16	50.138	21:26:16	50.145
20:36:17	49.867	20:46:17	49.824	20:56:17	49.963	21:06:17	50.215	21:16:17	50.135	21:26:17	50.144
20:36:18	49.868	20:46:18	49.822	20:56:18	49.964	21:06:18	50.217	21:16:18	50.133	21:26:18	50.144
20:36:19	49.868	20:46:19	49.820	20:56:19	49.963	21:06:19	50.216	21:16:19	50.130	21:26:19	50.143
20:36:20	49.868	20:46:20	49.819	20:56:20	49.963	21:06:20	50.217	21:16:20	50.127	21:26:20	50.144
20:36:21	49.866	20:46:21	49.818	20:56:21	49.960	21:06:21	50.218	21:16:21	50.125	21:26:21	50.142
20:36:22	49.867	20:46:22	49.815	20:56:22	49.960	21:06:22	50.219	21:16:22	50.122	21:26:22	50.141
20:36:23	49.868	20:46:23	49.815	20:56:23	49.957	21:06:23	50.217	21:16:23	50.120	21:26:23	50.141
20:36:24	49.869	20:46:24	49.814	20:56:24	49.956	21:06:24	50.219	21:16:24	50.116	21:26:24	50.140
20:36:25	49.867	20:46:25	49.812	20:56:25	49.955	21:06:25	50.219	21:16:25	50.114	21:26:25	50.140
20:36:26	49.869	20:46:26	49.810	20:56:26	49.955	21:06:26	50.220	21:16:26	50.111	21:26:26	50.141
20:36:27	49.868	20:46:27	49.810	20:56:27	49.955	21:06:27	50.221	21:16:27	50.108	21:26:27	50.140
20:36:28	49.868	20:46:28	49.807	20:56:28	49.953	21:06:28	50.221	21:16:28	50.105	21:26:28	50.139
20:36:29	49.869	20:46:29	49.805	20:56:29	49.953	21:06:29	50.221	21:16:29	50.103	21:26:29	50.136
20:36:30	49.871	20:46:30	49.805	20:56:30	49.954	21:06:30	50.220	21:16:30	50.100	21:26:30	50.139
20:36:31	49.869	20:46:31	49.804	20:56:31	49.954	21:06:31	50.222	21:16:31	50.098	21:26:31	50.141
20:36:32	49.869	20:46:32	49.802	20:56:32	49.953	21:06:32	50.221	21:16:32	50.095	21:26:32	50.139
20:36:33	49.870	20:46:33	49.800	20:56:33	49.952	21:06:33	50.222	21:16:33	50.095	21:26:33	50.140
20:36:34	49.870	20:46:34	49.799	20:56:34	49.954	21:06:34	50.222	21:16:34	50.094	21:26:34	50.141
20:36:35	49.872	20:46:35	49.798	20:56:35	49.953	21:06:35	50.224	21:16:35	50.094	21:26:35	50.141
20:36:36	49.872	20:46:36	49.795	20:56:36	49.953	21:06:36	50.223	21:16:36	50.097	21:26:36	50.142
20:36:37	49.871	20:46:37	49.795	20:56:37	49.953	21:06:37	50.225	21:16:37	50.096	21:26:37	50.141
20:36:38	49.868	20:46:38	49.794	20:56:38	49.952	21:06:38	50.224	21:16:38	50.097	21:26:38	50.143
20:36:39	49.868	20:46:39	49.794	20:56:39	49.954	21:06:39	50.226	21:16:39	50.097	21:26:39	50.146
20:36:40	49.866	20:46:40	49.795	20:56:40	49.954	21:06:40	50.225	21:16:40	50.098	21:26:40	50.146
20:36:41	49.865	20:46:41	49.794	20:56:41	49.954	21:06:41	50.226	21:16:41	50.097	21:26:41	50.147
20:36:42	49.864	20:46:42	49.794	20:56:42	49.955	21:06:42	50.226	21:16:42	50.096	21:26:42	50.148
20:36:43	49.862	20:46:43	49.795	20:56:43	49.956	21:06:43	50.226	21:16:43	50.096	21:26:43	50.149
20:36:44	49.860	20:46:44	49.794	20:56:44	49.956	21:06:44	50.226	21:16:44	50.096	21:26:44	50.151
20:36:45	49.859	20:46:45	49.793	20:56:45	49.956	21:06:45	50.227	21:16:45	50.094	21:26:45	50.151
20:36:46	49.858	20:46:46	49.794	20:56:46	49.956	21:06:46	50.227	21:16:46	50.094	21:26:46	50.152

Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)
20:36:47	49.857	20:46:47	49.792	20:56:47	49.956	21:06:47	50.228	21:16:47	50.095	21:26:47	50.153
20:36:48	49.855	20:46:48	49.792	20:56:48	49.953	21:06:48	50.228	21:16:48	50.093	21:26:48	50.154
20:36:49	49.852	20:46:49	49.790	20:56:49	49.952	21:06:49	50.228	21:16:49	50.093	21:26:49	50.154
20:36:50	49.851	20:46:50	49.791	20:56:50	49.950	21:06:50	50.229	21:16:50	50.095	21:26:50	50.155
20:36:51	49.851	20:46:51	49.789	20:56:51	49.949	21:06:51	50.230	21:16:51	50.094	21:26:51	50.152
20:36:52	49.851	20:46:52	49.789	20:56:52	49.948	21:06:52	50.230	21:16:52	50.095	21:26:52	50.153
20:36:53	49.850	20:46:53	49.786	20:56:53	49.947	21:06:53	50.230	21:16:53	50.095	21:26:53	50.152
20:36:54	49.849	20:46:54	49.787	20:56:54	49.947	21:06:54	50.232	21:16:54	50.094	21:26:54	50.153
20:36:55	49.849	20:46:55	49.787	20:56:55	49.946	21:06:55	50.231	21:16:55	50.095	21:26:55	50.152
20:36:56	49.849	20:46:56	49.787	20:56:56	49.946	21:06:56	50.233	21:16:56	50.093	21:26:56	50.151
20:36:57	49.851	20:46:57	49.786	20:56:57	49.945	21:06:57	50.234	21:16:57	50.092	21:26:57	50.152
20:36:58	49.849	20:46:58	49.787	20:56:58	49.945	21:06:58	50.235	21:16:58	50.091	21:26:58	50.150
20:36:59	49.850	20:46:59	49.786	20:56:59	49.944	21:06:59	50.236	21:16:59	50.091	21:26:59	50.151
20:37:00	49.850	20:47:00	49.787	20:57:00	49.944	21:07:00	50.237	21:17:00	50.090	21:27:00	50.151
20:37:01	49.851	20:47:01	49.787	20:57:01	49.942	21:07:01	50.239	21:17:01	50.090	21:27:01	50.149
20:37:02	49.850	20:47:02	49.787	20:57:02	49.942	21:07:02	50.239	21:17:02	50.091	21:27:02	50.149
20:37:03	49.849	20:47:03	49.787	20:57:03	49.940	21:07:03	50.239	21:17:03	50.090	21:27:03	50.147
20:37:04	49.848	20:47:04	49.789	20:57:04	49.939	21:07:04	50.240	21:17:04	50.092	21:27:04	50.146
20:37:05	49.848	20:47:05	49.788	20:57:05	49.937	21:07:05	50.240	21:17:05	50.093	21:27:05	50.145
20:37:06	49.847	20:47:06	49.788	20:57:06	49.936	21:07:06	50.241	21:17:06	50.094	21:27:06	50.142
20:37:07	49.846	20:47:07	49.787	20:57:07	49.934	21:07:07	50.240	21:17:07	50.094	21:27:07	50.141
20:37:08	49.845	20:47:08	49.786	20:57:08	49.931	21:07:08	50.242	21:17:08	50.094	21:27:08	50.139
20:37:09	49.846	20:47:09	49.785	20:57:09	49.928	21:07:09	50.241	21:17:09	50.094	21:27:09	50.138
20:37:10	49.845	20:47:10	49.785	20:57:10	49.926	21:07:10	50.242	21:17:10	50.094	21:27:10	50.137
20:37:11	49.847	20:47:11	49.784	20:57:11	49.921	21:07:11	50.242	21:17:11	50.093	21:27:11	50.134
20:37:12	49.847	20:47:12	49.784	20:57:12	49.918	21:07:12	50.242	21:17:12	50.093	21:27:12	50.136
20:37:13	49.847	20:47:13	49.783	20:57:13	49.914	21:07:13	50.243	21:17:13	50.093	21:27:13	50.136
20:37:14	49.849	20:47:14	49.782	20:57:14	49.912	21:07:14	50.243	21:17:14	50.090	21:27:14	50.136
20:37:15	49.849	20:47:15	49.783	20:57:15	49.910	21:07:15	50.245	21:17:15	50.089	21:27:15	50.136
20:37:16	49.851	20:47:16	49.781	20:57:16	49.910	21:07:16	50.244	21:17:16	50.090	21:27:16	50.137
20:37:17	49.850	20:47:17	49.780	20:57:17	49.911	21:07:17	50.245	21:17:17	50.091	21:27:17	50.135
20:37:18	49.851	20:47:18	49.783	20:57:18	49.911	21:07:18	50.246	21:17:18	50.091	21:27:18	50.136
20:37:19	49.851	20:47:19	49.783	20:57:19	49.910	21:07:19	50.246	21:17:19	50.091	21:27:19	50.136
20:37:20	49.853	20:47:20	49.782	20:57:20	49.912	21:07:20	50.248	21:17:20	50.094	21:27:20	50.134
20:37:21	49.853	20:47:21	49.780	20:57:21	49.912	21:07:21	50.249	21:17:21	50.095	21:27:21	50.134
20:37:22	49.853	20:47:22	49.780	20:57:22	49.914	21:07:22	50.248	21:17:22	50.094	21:27:22	50.134
20:37:23	49.853	20:47:23	49.777	20:57:23	49.916	21:07:23	50.249	21:17:23	50.096	21:27:23	50.130
20:37:24	49.852	20:47:24	49.779	20:57:24	49.918	21:07:24	50.250	21:17:24	50.095	21:27:24	50.132
20:37:25	49.851	20:47:25	49.777	20:57:25	49.919	21:07:25	50.249	21:17:25	50.095	21:27:25	50.131
20:37:26	49.849	20:47:26	49.776	20:57:26	49.921	21:07:26	50.249	21:17:26	50.092	21:27:26	50.129
20:37:27	49.848	20:47:27	49.777	20:57:27	49.922	21:07:27	50.250	21:17:27	50.093	21:27:27	50.129

Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)
20:37:28	49.848	20:47:28	49.775	20:57:28	49.924	21:07:28	50.250	21:17:28	50.093	21:27:28	50.130
20:37:29	49.849	20:47:29	49.774	20:57:29	49.927	21:07:29	50.249	21:17:29	50.093	21:27:29	50.126
20:37:30	49.850	20:47:30	49.772	20:57:30	49.931	21:07:30	50.249	21:17:30	50.094	21:27:30	50.127
20:37:31	49.848	20:47:31	49.771	20:57:31	49.934	21:07:31	50.250	21:17:31	50.094	21:27:31	50.127
20:37:32	49.848	20:47:32	49.769	20:57:32	49.939	21:07:32	50.249	21:17:32	50.094	21:27:32	50.126
20:37:33	49.848	20:47:33	49.767	20:57:33	49.943	21:07:33	50.248	21:17:33	50.092	21:27:33	50.127
20:37:34	49.848	20:47:34	49.765	20:57:34	49.947	21:07:34	50.249	21:17:34	50.094	21:27:34	50.126
20:37:35	49.847	20:47:35	49.764	20:57:35	49.950	21:07:35	50.248	21:17:35	50.095	21:27:35	50.126
20:37:36	49.845	20:47:36	49.763	20:57:36	49.953	21:07:36	50.248	21:17:36	50.096	21:27:36	50.126
20:37:37	49.846	20:47:37	49.762	20:57:37	49.959	21:07:37	50.248	21:17:37	50.096	21:27:37	50.126
20:37:38	49.846	20:47:38	49.762	20:57:38	49.962	21:07:38	50.246	21:17:38	50.095	21:27:38	50.125
20:37:39	49.845	20:47:39	49.761	20:57:39	49.962	21:07:39	50.247	21:17:39	50.096	21:27:39	50.126
20:37:40	49.844	20:47:40	49.761	20:57:40	49.965	21:07:40	50.247	21:17:40	50.097	21:27:40	50.125
20:37:41	49.841	20:47:41	49.762	20:57:41	49.967	21:07:41	50.248	21:17:41	50.097	21:27:41	50.125
20:37:42	49.842	20:47:42	49.764	20:57:42	49.968	21:07:42	50.248	21:17:42	50.100	21:27:42	50.125
20:37:43	49.841	20:47:43	49.763	20:57:43	49.971	21:07:43	50.249	21:17:43	50.102	21:27:43	50.123
20:37:44	49.840	20:47:44	49.765	20:57:44	49.973	21:07:44	50.251	21:17:44	50.102	21:27:44	50.123
20:37:45	49.837	20:47:45	49.766	20:57:45	49.974	21:07:45	50.249	21:17:45	50.106	21:27:45	50.122
20:37:46	49.836	20:47:46	49.766	20:57:46	49.974	21:07:46	50.250	21:17:46	50.106	21:27:46	50.121
20:37:47	49.837	20:47:47	49.766	20:57:47	49.975	21:07:47	50.251	21:17:47	50.107	21:27:47	50.119
20:37:48	49.836	20:47:48	49.766	20:57:48	49.976	21:07:48	50.250	21:17:48	50.109	21:27:48	50.118
20:37:49	49.836	20:47:49	49.766	20:57:49	49.977	21:07:49	50.250	21:17:49	50.109	21:27:49	50.117
20:37:50	49.836	20:47:50	49.765	20:57:50	49.978	21:07:50	50.248	21:17:50	50.110	21:27:50	50.116
20:37:51	49.837	20:47:51	49.764	20:57:51	49.977	21:07:51	50.250	21:17:51	50.110	21:27:51	50.116
20:37:52	49.839	20:47:52	49.763	20:57:52	49.979	21:07:52	50.249	21:17:52	50.111	21:27:52	50.115
20:37:53	49.837	20:47:53	49.762	20:57:53	49.979	21:07:53	50.249	21:17:53	50.111	21:27:53	50.116
20:37:54	49.839	20:47:54	49.760	20:57:54	49.980	21:07:54	50.249	21:17:54	50.112	21:27:54	50.115
20:37:55	49.841	20:47:55	49.760	20:57:55	49.979	21:07:55	50.250	21:17:55	50.114	21:27:55	50.113
20:37:56	49.843	20:47:56	49.760	20:57:56	49.980	21:07:56	50.250	21:17:56	50.117	21:27:56	50.112
20:37:57	49.843	20:47:57	49.757	20:57:57	49.981	21:07:57	50.250	21:17:57	50.119	21:27:57	50.112
20:37:58	49.842	20:47:58	49.757	20:57:58	49.981	21:07:58	50.252	21:17:58	50.123	21:27:58	50.111
20:37:59	49.843	20:47:59	49.756	20:57:59	49.982	21:07:59	50.250	21:17:59	50.125	21:27:59	50.109
20:38:00	49.843	20:48:00	49.755	20:58:00	49.985	21:08:00	50.250	21:18:00	50.126	21:28:00	50.110
20:38:01	49.843	20:48:01	49.754	20:58:01	49.985	21:08:01	50.250	21:18:01	50.128	21:28:01	50.110
20:38:02	49.840	20:48:02	49.751	20:58:02	49.988	21:08:02	50.250	21:18:02	50.129	21:28:02	50.109
20:38:03	49.840	20:48:03	49.751	20:58:03	49.992	21:08:03	50.250	21:18:03	50.129	21:28:03	50.108
20:38:04	49.841	20:48:04	49.750	20:58:04	49.996	21:08:04	50.249	21:18:04	50.129	21:28:04	50.109
20:38:05	49.841	20:48:05	49.750	20:58:05	50.001	21:08:05	50.249	21:18:05	50.132	21:28:05	50.109
20:38:06	49.842	20:48:06	49.750	20:58:06	50.005	21:08:06	50.249	21:18:06	50.131	21:28:06	50.110
20:38:07	49.842	20:48:07	49.748	20:58:07	50.011	21:08:07	50.248	21:18:07	50.132	21:28:07	50.111
20:38:08	49.843	20:48:08	49.750	20:58:08	50.015	21:08:08	50.250	21:18:08	50.133	21:28:08	50.112

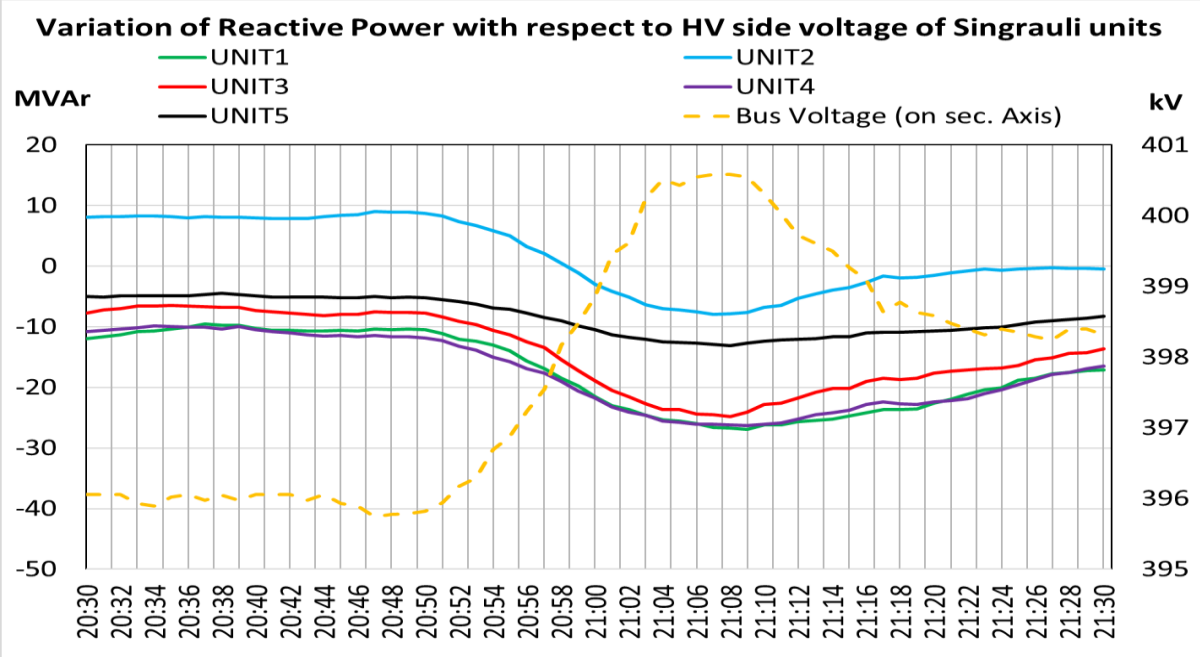
Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)
20:38:09	49.842	20:48:09	49.750	20:58:09	50.020	21:08:09	50.250	21:18:09	50.133	21:28:09	50.115
20:38:10	49.842	20:48:10	49.751	20:58:10	50.024	21:08:10	50.250	21:18:10	50.136	21:28:10	50.114
20:38:11	49.843	20:48:11	49.749	20:58:11	50.028	21:08:11	50.250	21:18:11	50.135	21:28:11	50.116
20:38:12	49.842	20:48:12	49.749	20:58:12	50.030	21:08:12	50.249	21:18:12	50.138	21:28:12	50.116
20:38:13	49.844	20:48:13	49.748	20:58:13	50.033	21:08:13	50.250	21:18:13	50.138	21:28:13	50.117
20:38:14	49.845	20:48:14	49.748	20:58:14	50.037	21:08:14	50.249	21:18:14	50.138	21:28:14	50.120
20:38:15	49.846	20:48:15	49.748	20:58:15	50.038	21:08:15	50.251	21:18:15	50.141	21:28:15	50.120
20:38:16	49.846	20:48:16	49.746	20:58:16	50.040	21:08:16	50.251	21:18:16	50.140	21:28:16	50.122
20:38:17	49.846	20:48:17	49.748	20:58:17	50.041	21:08:17	50.252	21:18:17	50.140	21:28:17	50.124
20:38:18	49.845	20:48:18	49.745	20:58:18	50.042	21:08:18	50.252	21:18:18	50.141	21:28:18	50.124
20:38:19	49.845	20:48:19	49.745	20:58:19	50.042	21:08:19	50.252	21:18:19	50.139	21:28:19	50.124
20:38:20	49.843	20:48:20	49.745	20:58:20	50.044	21:08:20	50.252	21:18:20	50.139	21:28:20	50.124
20:38:21	49.843	20:48:21	49.743	20:58:21	50.047	21:08:21	50.251	21:18:21	50.140	21:28:21	50.126
20:38:22	49.842	20:48:22	49.741	20:58:22	50.047	21:08:22	50.252	21:18:22	50.142	21:28:22	50.127
20:38:23	49.842	20:48:23	49.739	20:58:23	50.047	21:08:23	50.253	21:18:23	50.140	21:28:23	50.128
20:38:24	49.840	20:48:24	49.740	20:58:24	50.046	21:08:24	50.254	21:18:24	50.142	21:28:24	50.128
20:38:25	49.840	20:48:25	49.738	20:58:25	50.047	21:08:25	50.254	21:18:25	50.143	21:28:25	50.128
20:38:26	49.839	20:48:26	49.737	20:58:26	50.049	21:08:26	50.253	21:18:26	50.146	21:28:26	50.129
20:38:27	49.839	20:48:27	49.737	20:58:27	50.049	21:08:27	50.255	21:18:27	50.148	21:28:27	50.129
20:38:28	49.838	20:48:28	49.737	20:58:28	50.051	21:08:28	50.256	21:18:28	50.148	21:28:28	50.130
20:38:29	49.837	20:48:29	49.737	20:58:29	50.050	21:08:29	50.255	21:18:29	50.152	21:28:29	50.130
20:38:30	49.837	20:48:30	49.736	20:58:30	50.050	21:08:30	50.258	21:18:30	50.153	21:28:30	50.129
20:38:31	49.836	20:48:31	49.736	20:58:31	50.052	21:08:31	50.256	21:18:31	50.154	21:28:31	50.130
20:38:32	49.837	20:48:32	49.735	20:58:32	50.054	21:08:32	50.259	21:18:32	50.156	21:28:32	50.130
20:38:33	49.836	20:48:33	49.734	20:58:33	50.053	21:08:33	50.258	21:18:33	50.158	21:28:33	50.130
20:38:34	49.835	20:48:34	49.733	20:58:34	50.052	21:08:34	50.260	21:18:34	50.161	21:28:34	50.131
20:38:35	49.833	20:48:35	49.734	20:58:35	50.051	21:08:35	50.260	21:18:35	50.160	21:28:35	50.130
20:38:36	49.832	20:48:36	49.734	20:58:36	50.052	21:08:36	50.259	21:18:36	50.162	21:28:36	50.129
20:38:37	49.832	20:48:37	49.733	20:58:37	50.052	21:08:37	50.261	21:18:37	50.163	21:28:37	50.130
20:38:38	49.831	20:48:38	49.733	20:58:38	50.052	21:08:38	50.260	21:18:38	50.162	21:28:38	50.129
20:38:39	49.830	20:48:39	49.733	20:58:39	50.051	21:08:39	50.259	21:18:39	50.164	21:28:39	50.128
20:38:40	49.830	20:48:40	49.732	20:58:40	50.050	21:08:40	50.261	21:18:40	50.165	21:28:40	50.128
20:38:41	49.830	20:48:41	49.731	20:58:41	50.049	21:08:41	50.259	21:18:41	50.167	21:28:41	50.127
20:38:42	49.829	20:48:42	49.731	20:58:42	50.050	21:08:42	50.260	21:18:42	50.167	21:28:42	50.126
20:38:43	49.828	20:48:43	49.731	20:58:43	50.051	21:08:43	50.259	21:18:43	50.169	21:28:43	50.127
20:38:44	49.829	20:48:44	49.729	20:58:44	50.052	21:08:44	50.257	21:18:44	50.172	21:28:44	50.126
20:38:45	49.829	20:48:45	49.727	20:58:45	50.051	21:08:45	50.258	21:18:45	50.172	21:28:45	50.126
20:38:46	49.828	20:48:46	49.727	20:58:46	50.052	21:08:46	50.256	21:18:46	50.174	21:28:46	50.126
20:38:47	49.829	20:48:47	49.725	20:58:47	50.053	21:08:47	50.256	21:18:47	50.174	21:28:47	50.123
20:38:48	49.831	20:48:48	49.724	20:58:48	50.054	21:08:48	50.255	21:18:48	50.176	21:28:48	50.121
20:38:49	49.832	20:48:49	49.723	20:58:49	50.053	21:08:49	50.253	21:18:49	50.177	21:28:49	50.120

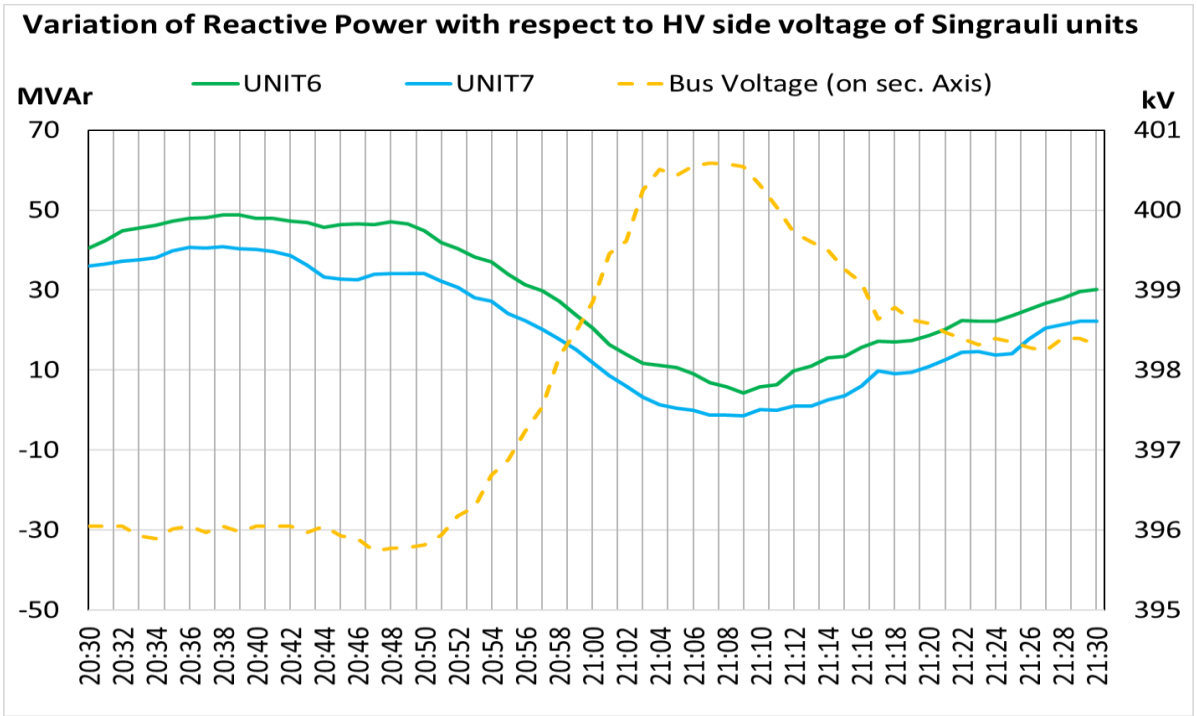
Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)
20:38:50	49.831	20:48:50	49.724	20:58:50	50.051	21:08:50	50.253	21:18:50	50.177	21:28:50	50.118
20:38:51	49.831	20:48:51	49.724	20:58:51	50.050	21:08:51	50.253	21:18:51	50.179	21:28:51	50.117
20:38:52	49.833	20:48:52	49.724	20:58:52	50.049	21:08:52	50.253	21:18:52	50.177	21:28:52	50.116
20:38:53	49.832	20:48:53	49.725	20:58:53	50.048	21:08:53	50.253	21:18:53	50.179	21:28:53	50.116
20:38:54	49.830	20:48:54	49.724	20:58:54	50.047	21:08:54	50.253	21:18:54	50.177	21:28:54	50.114
20:38:55	49.828	20:48:55	49.725	20:58:55	50.044	21:08:55	50.255	21:18:55	50.175	21:28:55	50.115
20:38:56	49.828	20:48:56	49.724	20:58:56	50.042	21:08:56	50.253	21:18:56	50.174	21:28:56	50.114
20:38:57	49.828	20:48:57	49.724	20:58:57	50.039	21:08:57	50.254	21:18:57	50.174	21:28:57	50.113
20:38:58	49.827	20:48:58	49.726	20:58:58	50.037	21:08:58	50.255	21:18:58	50.175	21:28:58	50.112
20:38:59	49.826	20:48:59	49.727	20:58:59	50.035	21:08:59	50.255	21:18:59	50.175	21:28:59	50.111
20:39:00	49.828	20:49:00	49.726	20:59:00	50.032	21:09:00	50.255	21:19:00	50.177	21:29:00	50.110
20:39:01	49.827	20:49:01	49.725	20:59:01	50.031	21:09:01	50.254	21:19:01	50.177	21:29:01	50.109
20:39:02	49.826	20:49:02	49.725	20:59:02	50.028	21:09:02	50.255	21:19:02	50.178	21:29:02	50.110
20:39:03	49.826	20:49:03	49.724	20:59:03	50.026	21:09:03	50.253	21:19:03	50.177	21:29:03	50.109
20:39:04	49.827	20:49:04	49.723	20:59:04	50.025	21:09:04	50.251	21:19:04	50.178	21:29:04	50.109
20:39:05	49.829	20:49:05	49.723	20:59:05	50.023	21:09:05	50.250	21:19:05	50.177	21:29:05	50.108
20:39:06	49.828	20:49:06	49.723	20:59:06	50.023	21:09:06	50.248	21:19:06	50.178	21:29:06	50.107
20:39:07	49.828	20:49:07	49.722	20:59:07	50.021	21:09:07	50.247	21:19:07	50.179	21:29:07	50.106
20:39:08	49.829	20:49:08	49.722	20:59:08	50.020	21:09:08	50.245	21:19:08	50.179	21:29:08	50.106
20:39:09	49.830	20:49:09	49.720	20:59:09	50.019	21:09:09	50.245	21:19:09	50.180	21:29:09	50.107
20:39:10	49.829	20:49:10	49.721	20:59:10	50.017	21:09:10	50.242	21:19:10	50.180	21:29:10	50.105
20:39:11	49.827	20:49:11	49.719	20:59:11	50.018	21:09:11	50.242	21:19:11	50.182	21:29:11	50.107
20:39:12	49.827	20:49:12	49.720	20:59:12	50.018	21:09:12	50.242	21:19:12	50.181	21:29:12	50.108
20:39:13	49.826	20:49:13	49.719	20:59:13	50.020	21:09:13	50.240	21:19:13	50.182	21:29:13	50.107
20:39:14	49.824	20:49:14	49.719	20:59:14	50.022	21:09:14	50.240	21:19:14	50.183	21:29:14	50.108
20:39:15	49.822	20:49:15	49.719	20:59:15	50.023	21:09:15	50.239	21:19:15	50.182	21:29:15	50.109
20:39:16	49.822	20:49:16	49.717	20:59:16	50.024	21:09:16	50.237	21:19:16	50.184	21:29:16	50.110
20:39:17	49.821	20:49:17	49.717	20:59:17	50.025	21:09:17	50.234	21:19:17	50.185	21:29:17	50.109
20:39:18	49.821	20:49:18	49.715	20:59:18	50.025	21:09:18	50.233	21:19:18	50.184	21:29:18	50.109
20:39:19	49.820	20:49:19	49.714	20:59:19	50.025	21:09:19	50.232	21:19:19	50.182	21:29:19	50.108
20:39:20	49.821	20:49:20	49.712	20:59:20	50.026	21:09:20	50.229	21:19:20	50.184	21:29:20	50.109
20:39:21	49.819	20:49:21	49.713	20:59:21	50.028	21:09:21	50.229	21:19:21	50.183	21:29:21	50.109
20:39:22	49.820	20:49:22	49.711	20:59:22	50.028	21:09:22	50.226	21:19:22	50.183	21:29:22	50.109
20:39:23	49.820	20:49:23	49.711	20:59:23	50.030	21:09:23	50.226	21:19:23	50.182	21:29:23	50.109
20:39:24	49.820	20:49:24	49.710	20:59:24	50.030	21:09:24	50.224	21:19:24	50.183	21:29:24	50.109
20:39:25	49.820	20:49:25	49.711	20:59:25	50.032	21:09:25	50.224	21:19:25	50.182	21:29:25	50.110
20:39:26	49.820	20:49:26	49.709	20:59:26	50.034	21:09:26	50.221	21:19:26	50.181	21:29:26	50.109
20:39:27	49.820	20:49:27	49.709	20:59:27	50.036	21:09:27	50.221	21:19:27	50.181	21:29:27	50.108
20:39:28	49.819	20:49:28	49.709	20:59:28	50.039	21:09:28	50.219	21:19:28	50.181	21:29:28	50.110
20:39:29	49.818	20:49:29	49.709	20:59:29	50.041	21:09:29	50.217	21:19:29	50.181	21:29:29	50.107
20:39:30	49.817	20:49:30	49.709	20:59:30	50.042	21:09:30	50.215	21:19:30	50.180	21:29:30	50.108

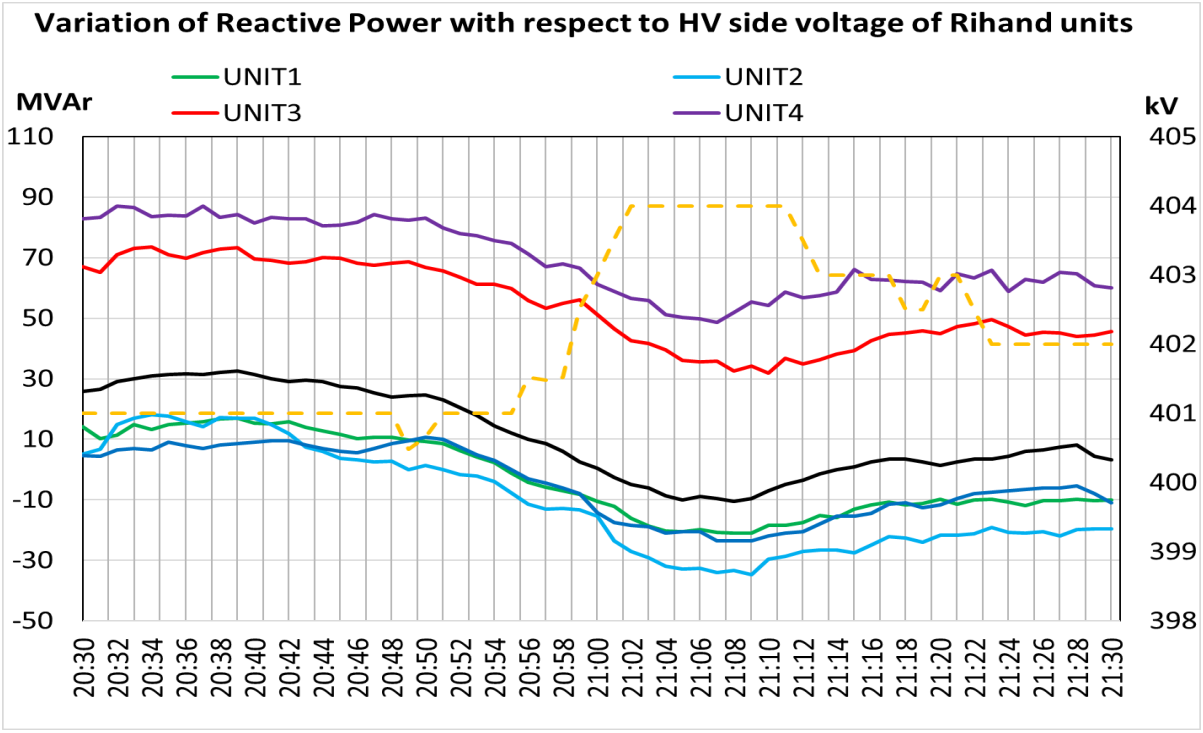
Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)	Time	Freq. (Hz)
20:39:31	49.817	20:49:31	49.710	20:59:31	50.044	21:09:31	50.214	21:19:31	50.179	21:29:31	50.108
20:39:32	49.816	20:49:32	49.709	20:59:32	50.046	21:09:32	50.213	21:19:32	50.178	21:29:32	50.110
20:39:33	49.817	20:49:33	49.710	20:59:33	50.051	21:09:33	50.211	21:19:33	50.180	21:29:33	50.109
20:39:34	49.815	20:49:34	49.709	20:59:34	50.052	21:09:34	50.209	21:19:34	50.176	21:29:34	50.109
20:39:35	49.816	20:49:35	49.709	20:59:35	50.055	21:09:35	50.208	21:19:35	50.177	21:29:35	50.110
20:39:36	49.816	20:49:36	49.709	20:59:36	50.056	21:09:36	50.208	21:19:36	50.179	21:29:36	50.109
20:39:37	49.817	20:49:37	49.709	20:59:37	50.057	21:09:37	50.206	21:19:37	50.179	21:29:37	50.109
20:39:38	49.817	20:49:38	49.708	20:59:38	50.059	21:09:38	50.204	21:19:38	50.180	21:29:38	50.110
20:39:39	49.817	20:49:39	49.709	20:59:39	50.060	21:09:39	50.204	21:19:39	50.179	21:29:39	50.110
20:39:40	49.817	20:49:40	49.709	20:59:40	50.062	21:09:40	50.202	21:19:40	50.179	21:29:40	50.110
20:39:41	49.817	20:49:41	49.709	20:59:41	50.062	21:09:41	50.201	21:19:41	50.177	21:29:41	50.110
20:39:42	49.818	20:49:42	49.709	20:59:42	50.064	21:09:42	50.200	21:19:42	50.178	21:29:42	50.111
20:39:43	49.818	20:49:43	49.709	20:59:43	50.068	21:09:43	50.197	21:19:43	50.176	21:29:43	50.109
20:39:44	49.820	20:49:44	49.712	20:59:44	50.070	21:09:44	50.196	21:19:44	50.175	21:29:44	50.109
20:39:45	49.819	20:49:45	49.711	20:59:45	50.074	21:09:45	50.193	21:19:45	50.175	21:29:45	50.108
20:39:46	49.819	20:49:46	49.712	20:59:46	50.074	21:09:46	50.192	21:19:46	50.174	21:29:46	50.106
20:39:47	49.818	20:49:47	49.712	20:59:47	50.078	21:09:47	50.191	21:19:47	50.175	21:29:47	50.105
20:39:48	49.820	20:49:48	49.714	20:59:48	50.080	21:09:48	50.190	21:19:48	50.174	21:29:48	50.105
20:39:49	49.821	20:49:49	49.714	20:59:49	50.081	21:09:49	50.189	21:19:49	50.174	21:29:49	50.105
20:39:50	49.821	20:49:50	49.717	20:59:50	50.082	21:09:50	50.187	21:19:50	50.174	21:29:50	50.105
20:39:51	49.822	20:49:51	49.719	20:59:51	50.082	21:09:51	50.187	21:19:51	50.173	21:29:51	50.104
20:39:52	49.823	20:49:52	49.721	20:59:52	50.084	21:09:52	50.185	21:19:52	50.174	21:29:52	50.103
20:39:53	49.823	20:49:53	49.723	20:59:53	50.083	21:09:53	50.185	21:19:53	50.173	21:29:53	50.102
20:39:54	49.824	20:49:54	49.724	20:59:54	50.084	21:09:54	50.182	21:19:54	50.175	21:29:54	50.101
20:39:55	49.826	20:49:55	49.726	20:59:55	50.086	21:09:55	50.181	21:19:55	50.173	21:29:55	50.100
20:39:56	49.827	20:49:56	49.725	20:59:56	50.088	21:09:56	50.179	21:19:56	50.173	21:29:56	50.100
20:39:57	49.826	20:49:57	49.725	20:59:57	50.091	21:09:57	50.179	21:19:57	50.173	21:29:57	50.099
20:39:58	49.826	20:49:58	49.725	20:59:58	50.093	21:09:58	50.178	21:19:58	50.173	21:29:58	50.099
20:39:59	49.826	20:49:59	49.725	20:59:59	50.096	21:09:59	50.175	21:19:59	50.173	21:29:59	50.098

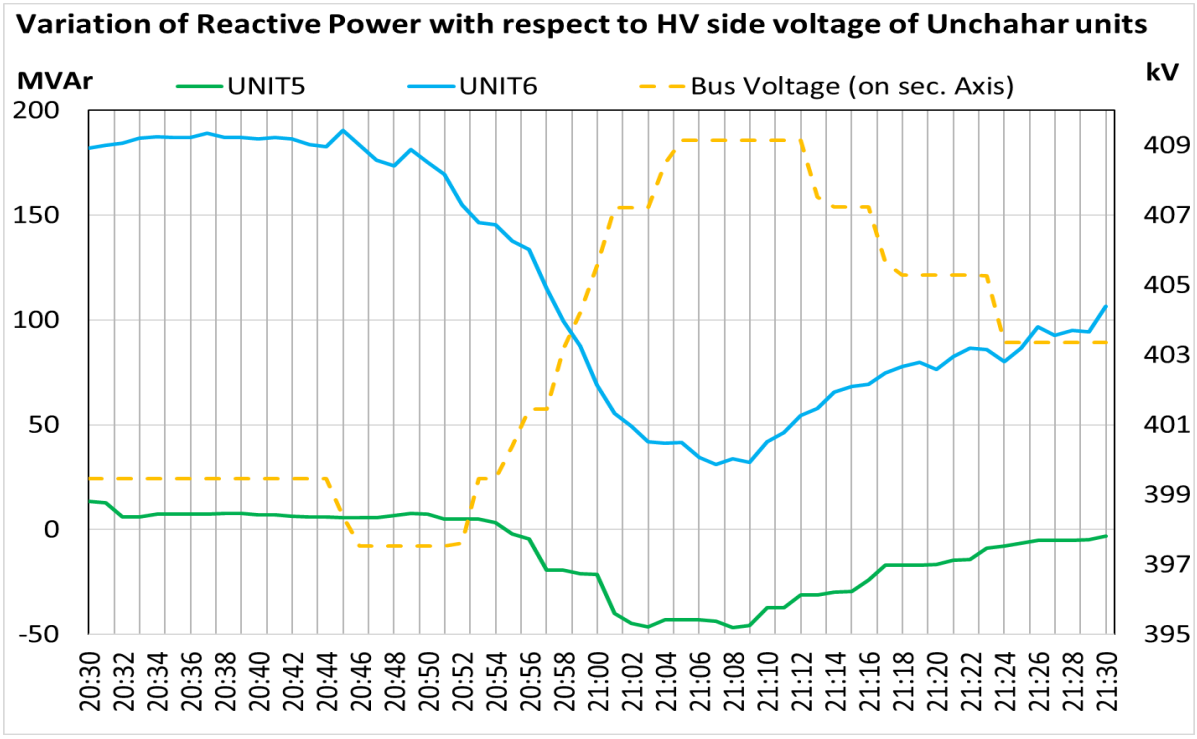
Annexure 11.1 Reactive Power Support by Generators

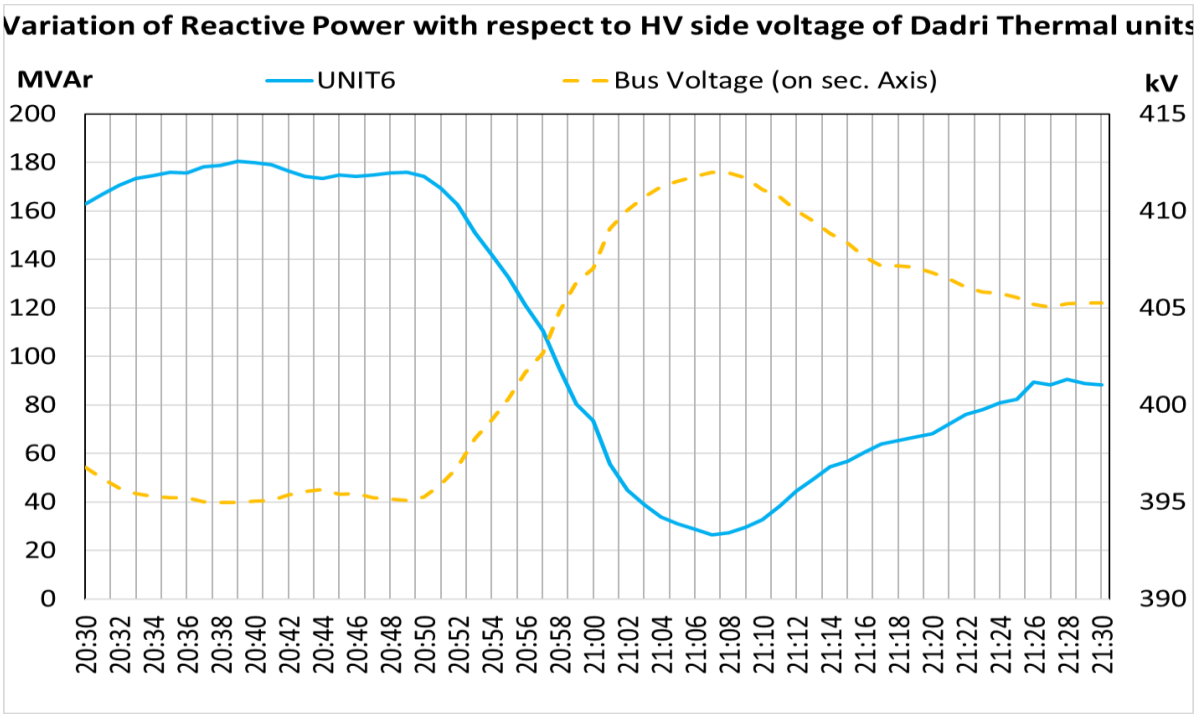
Northern Region

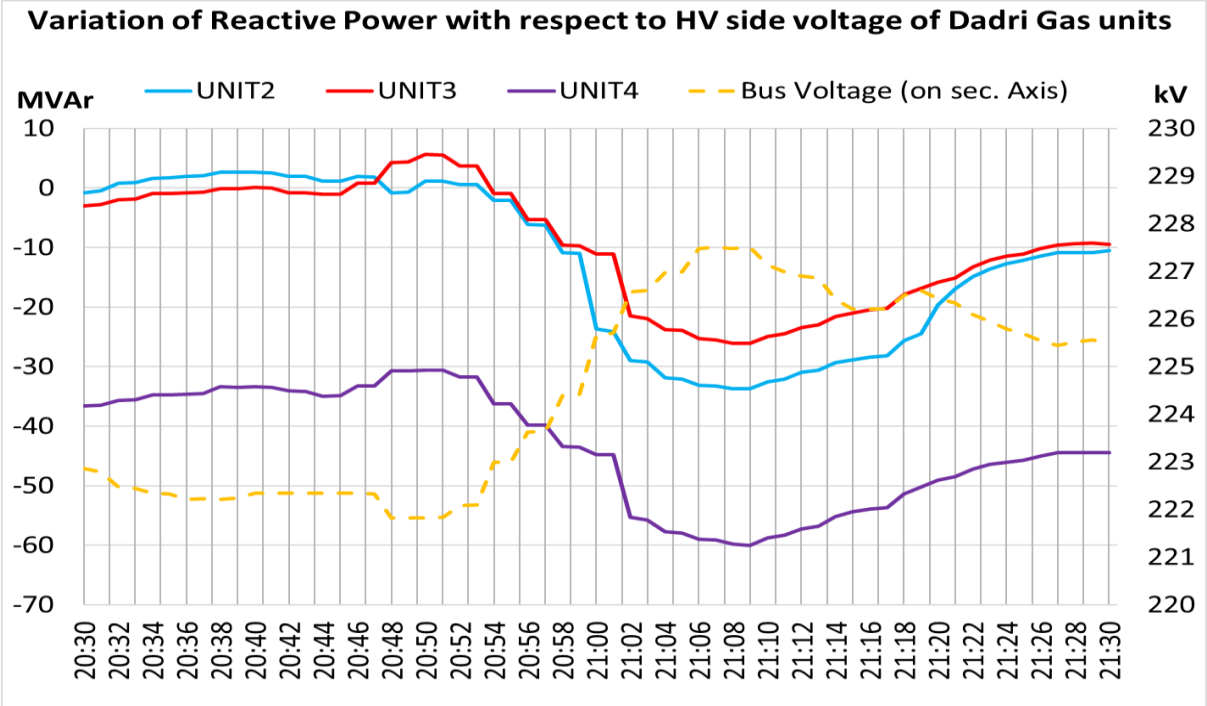


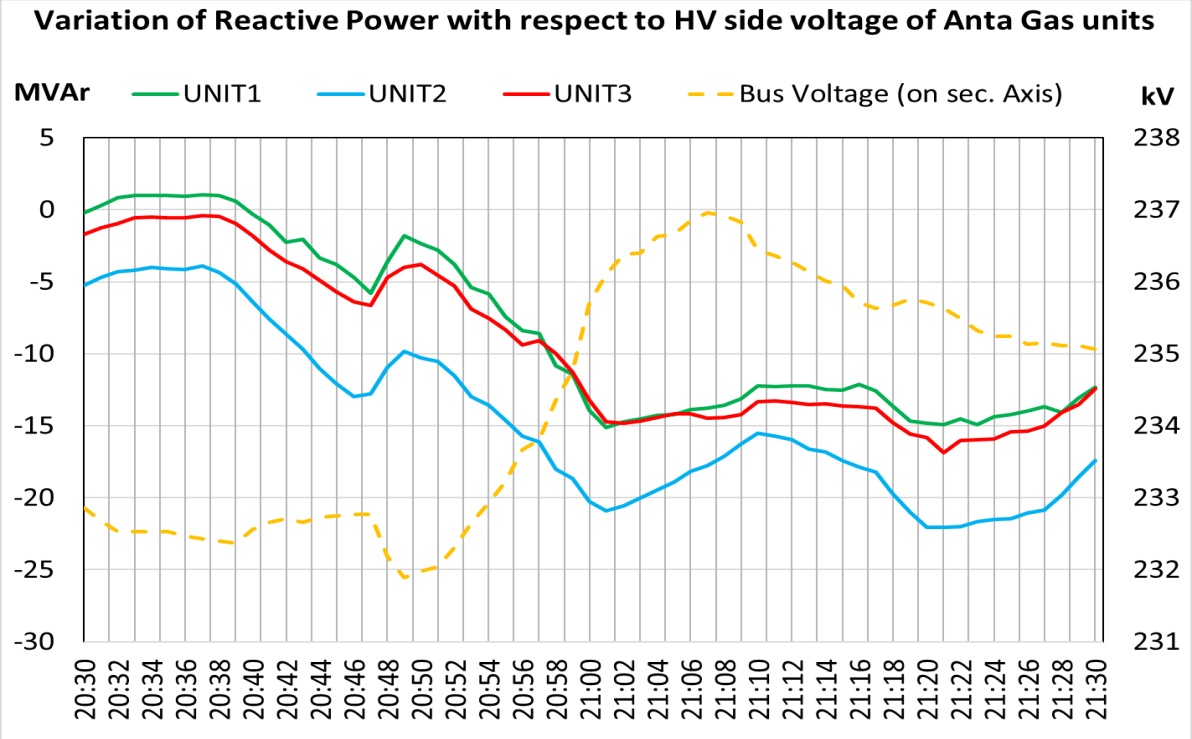


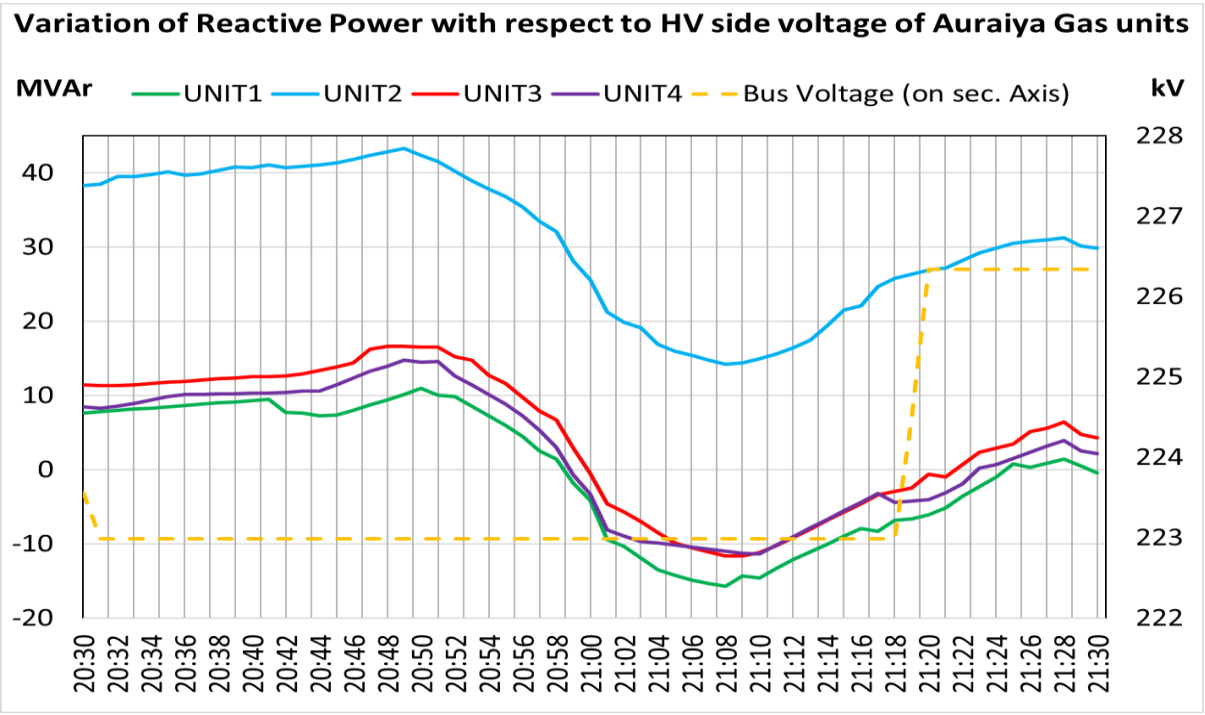

Variation of Reactive Power with respect to HV side voltage of Rihand units
MVAr
kV
UNIT1
UNIT2
UNIT3
UNIT4
110
90
70
50
30
10
-10
-30
-50
405
404
403
402
401
400
399
398
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of Unchahar units
MVAr
kV
UNIT5
UNIT6
Bus Voltage (on sec. Axis)
200
150
100
50
0
-50
409
407
405
403
401
399
397
395
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of Dadri Thermal units
MVAr
UNIT6
Bus Voltage (on sec. Axis)
kV
200
180
160
140
120
100
80
60
40
20
0
415
410
405
400
395
390
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of Dadri Gas units
MVAr
UNIT2
UNIT3
UNIT4
Bus Voltage (on sec. Axis)
kV
10
0
-10
-20
-30
-40
-50
-60
-70
230
229
228
227
226
225
224
223
222
221
220
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of Anta Gas units
MVAr
UNIT1
UNIT2
UNIT3
Bus Voltage (on sec. Axis)
kV
5
0
-5
-10
-15
-20
-25
-30
238
237
236
235
234
233
232
231
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of Auraiya Gas units
MVAr
UNIT1
UNIT2
UNIT3
UNIT4
Bus Voltage (on sec. Axis)
kV
40
30
20
10
0
-10
-20
228
227
226
225
224
223
222
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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21:14
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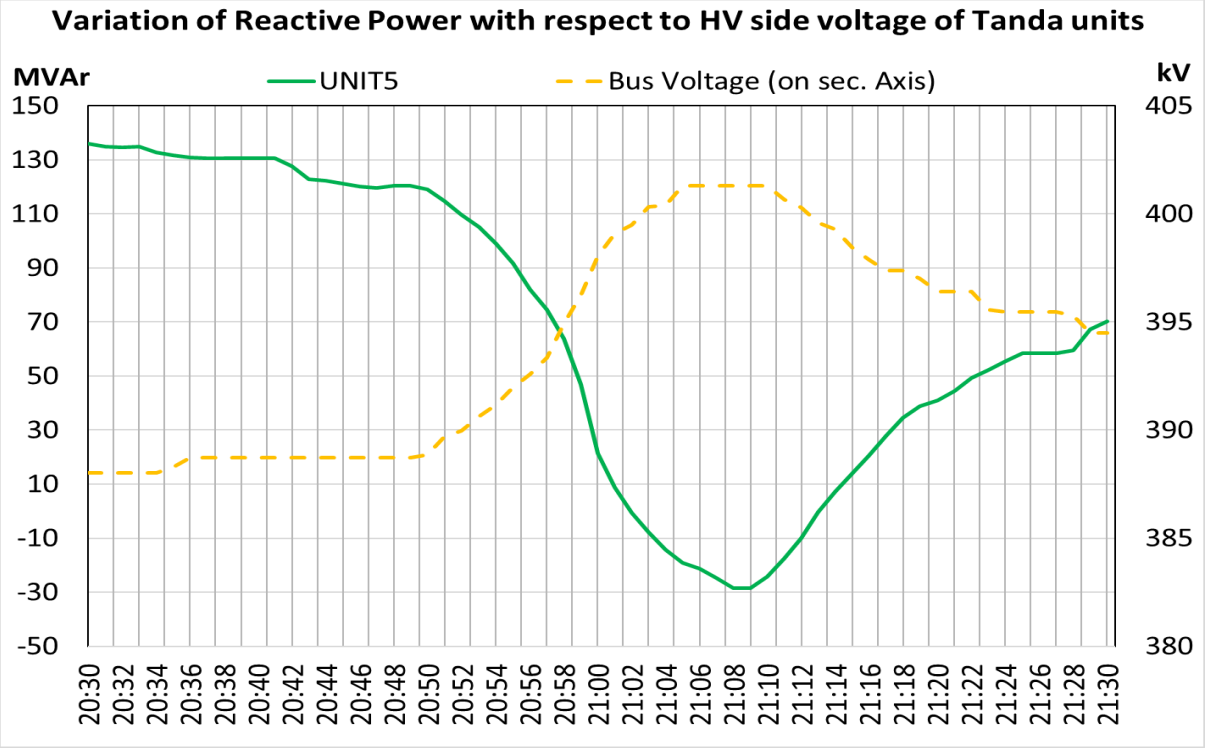
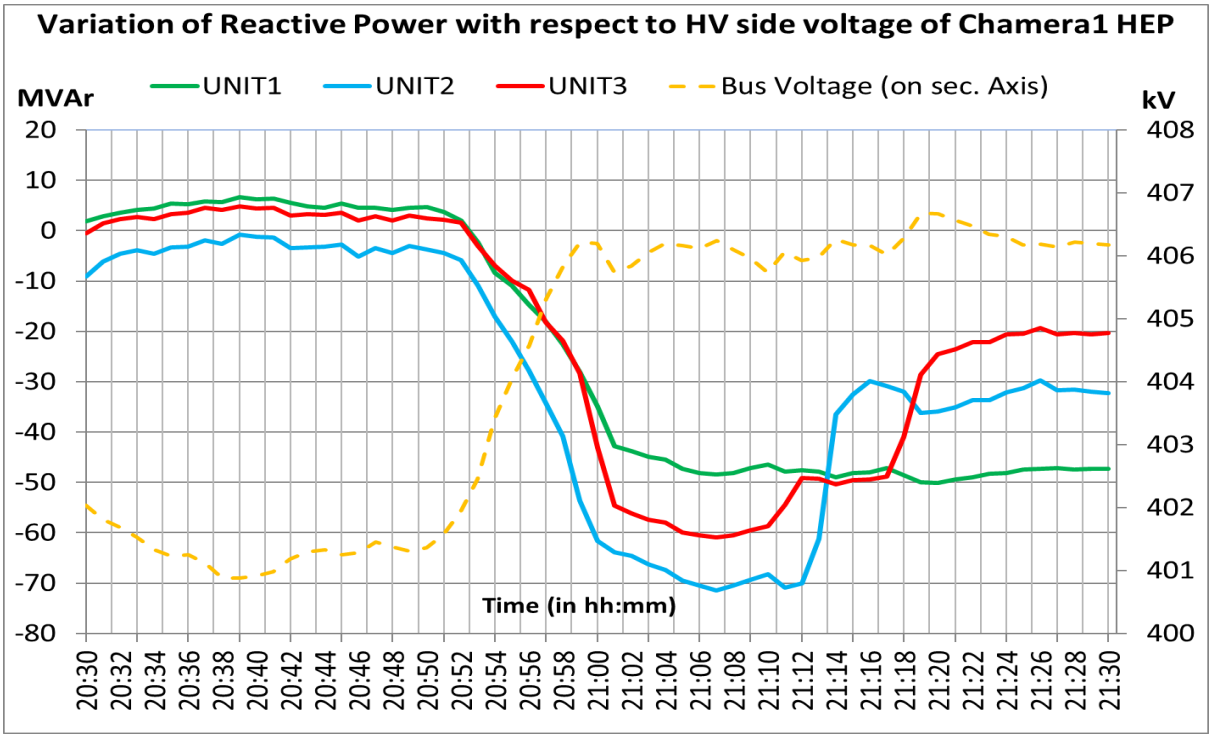
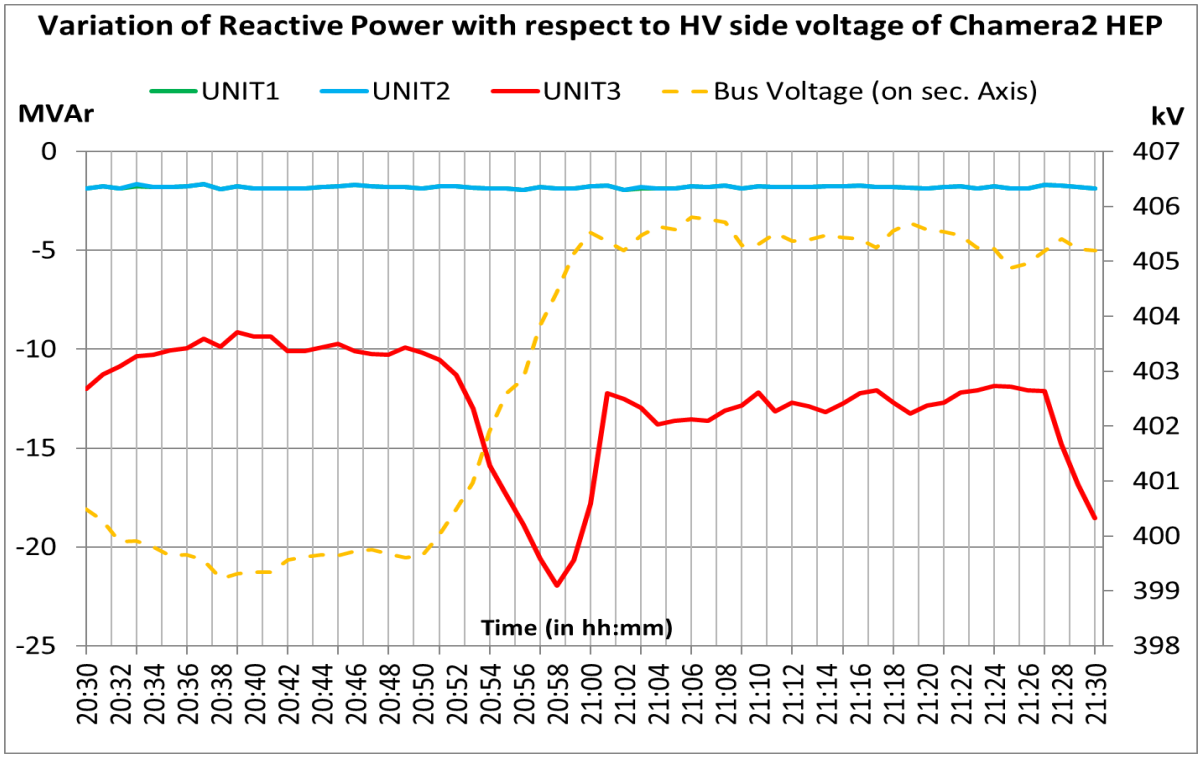
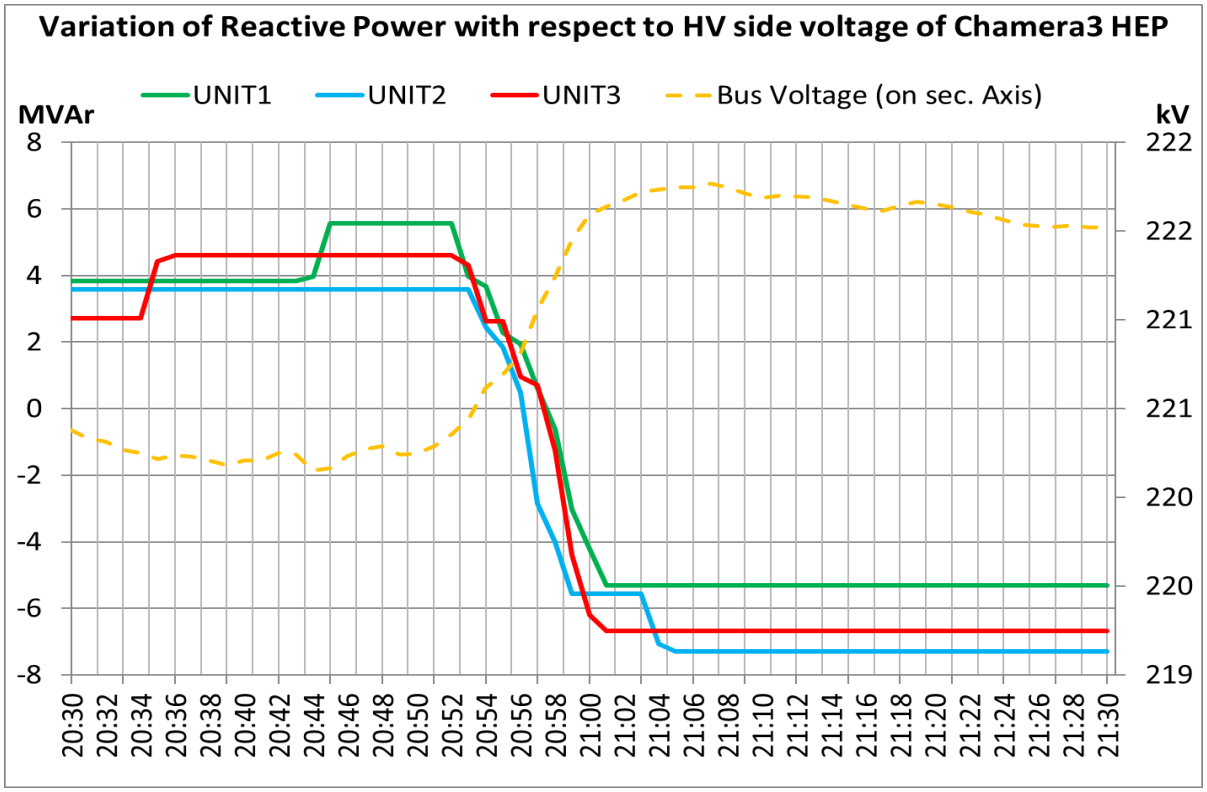
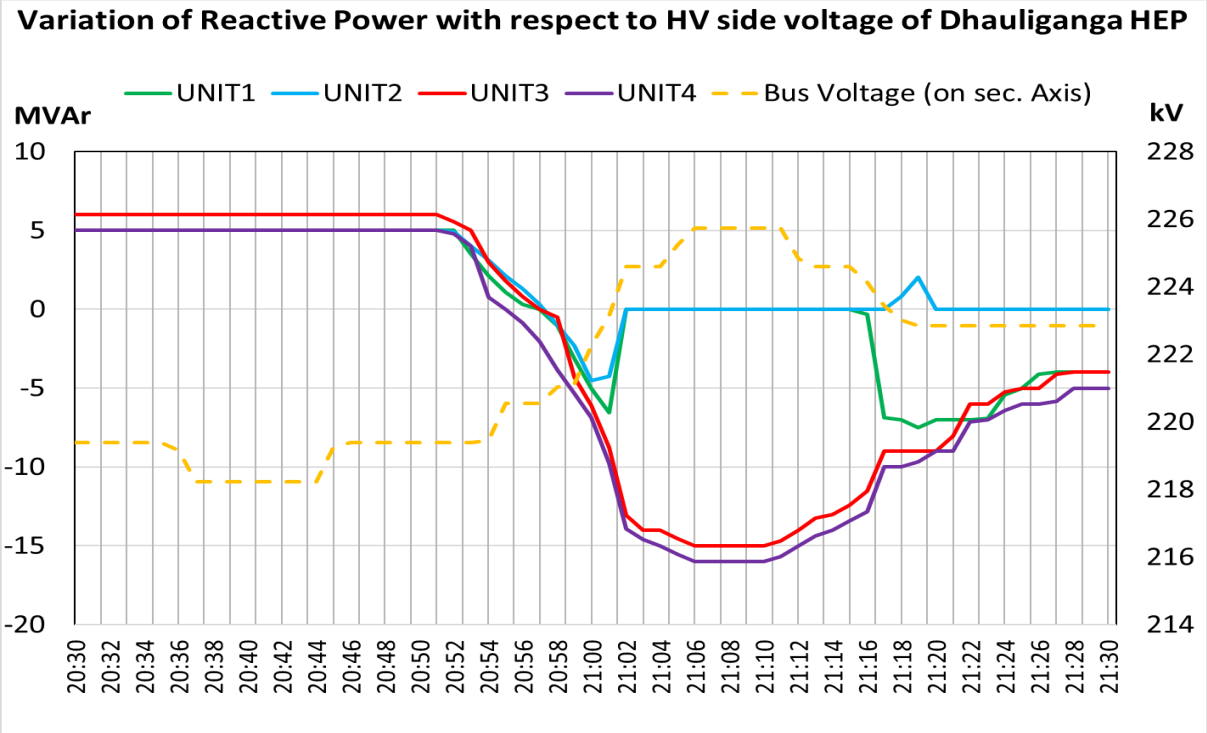
21:18
21:20
21:22
21:24
21:26
21:28
21:30

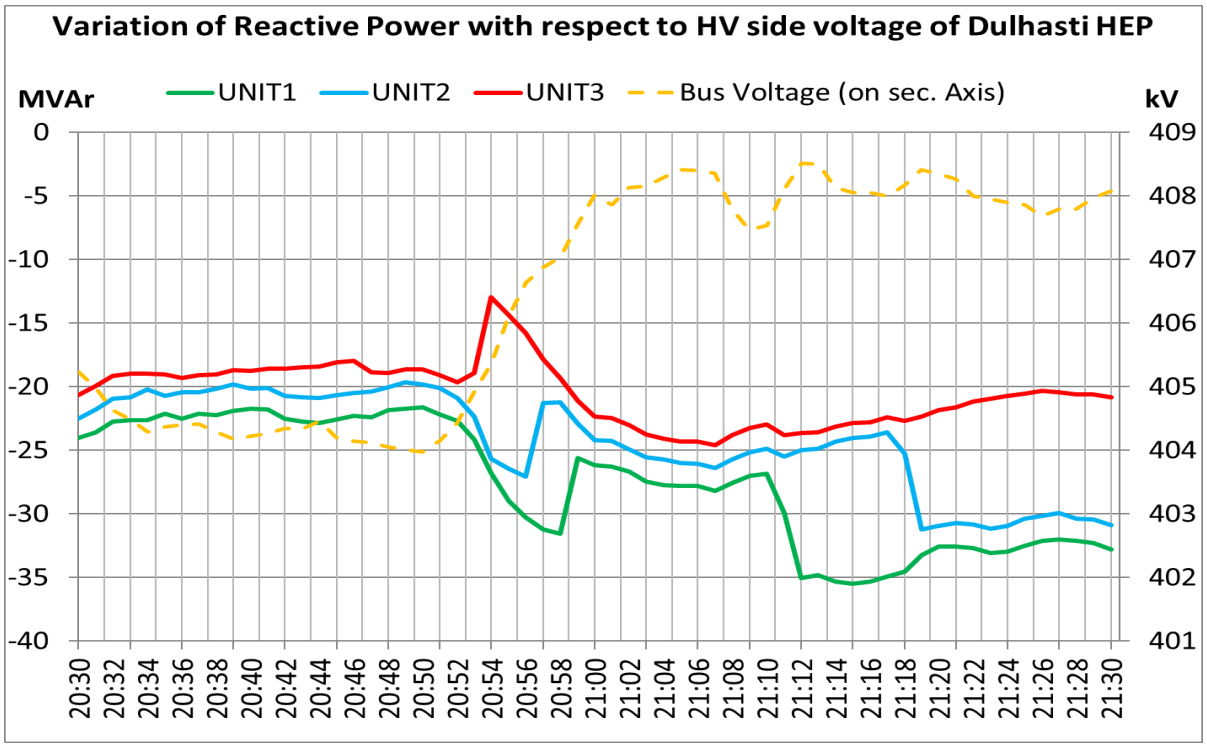

Variation of Reactive Power with respect to HV side voltage of Tanda units
MVAr
UNIT5
Bus Voltage (on sec. Axis)
kV
150
130
110
90
70
50
30
10
-10
-30
-50
405
400
395
390
385
380
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of Chamera1 HEP
MVAr
UNIT1
UNIT2
UNIT3
Bus Voltage (on sec. Axis)
kV
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
408
407
406
405
404
403
402
401
400
Time (in hh:mm)
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of Chamera2 HEP
UNIT1
UNIT2
UNIT3
Bus Voltage (on sec. Axis)
MVAr
kV
0
-5
-10
-15
-20
-25
407
406
405
404
403
402
401
400
399
398
Time (in hh:mm)
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of Chamera3 HEP
UNIT1
UNIT2
UNIT3
Bus Voltage (on sec. Axis)
MVAr
kV
8
6
4
2
0
-2
-4
-6
-8
222
222
221
221
220
220
219
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of Dhauliganga HEP
UNIT1
UNIT2
UNIT3
UNIT4
Bus Voltage (on sec. Axis)
MVAr
kV
10
5
0
-5
-10
-15
-20
228
226
224
222
220
218
216
214
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of Dulhasti HEP
UNIT1
UNIT2
UNIT3
Bus Voltage (on sec. Axis)
MVAr
kV
0
-5
-10
-15
-20
-25
-30
-35
-40
409
408
407
406
405
404
403
402
401
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
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21:18
21:20
21:22
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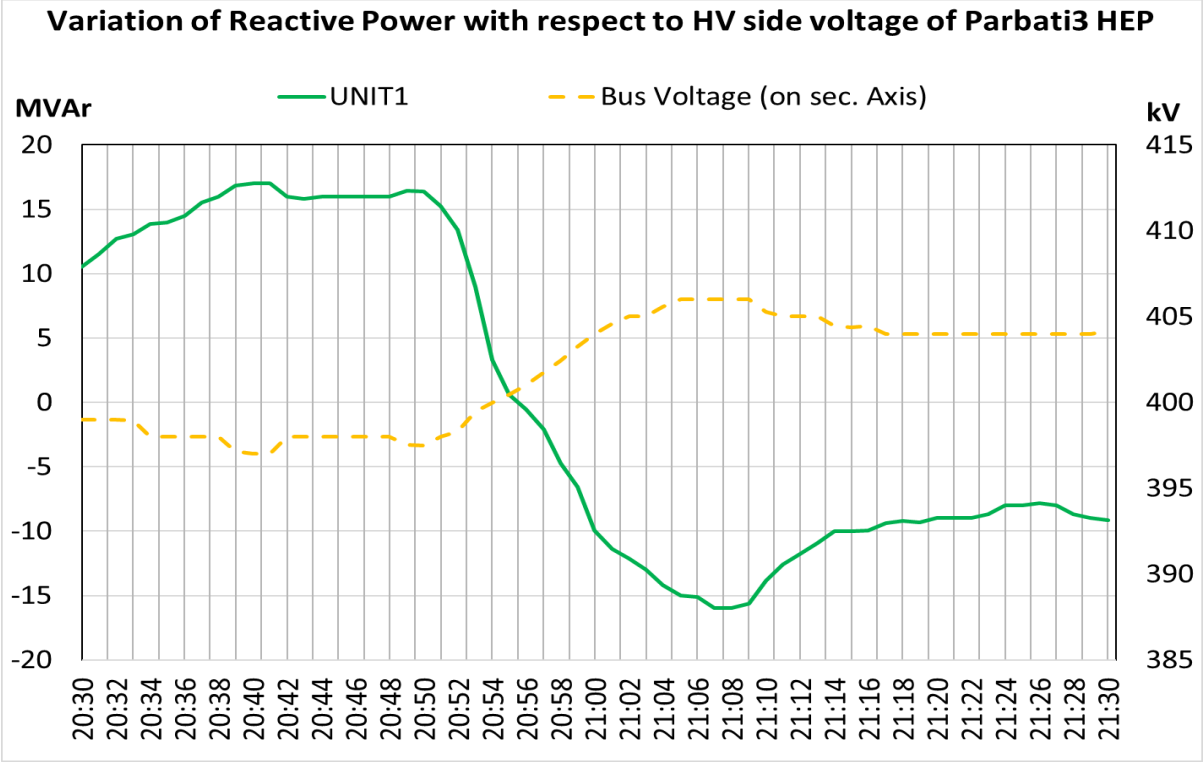
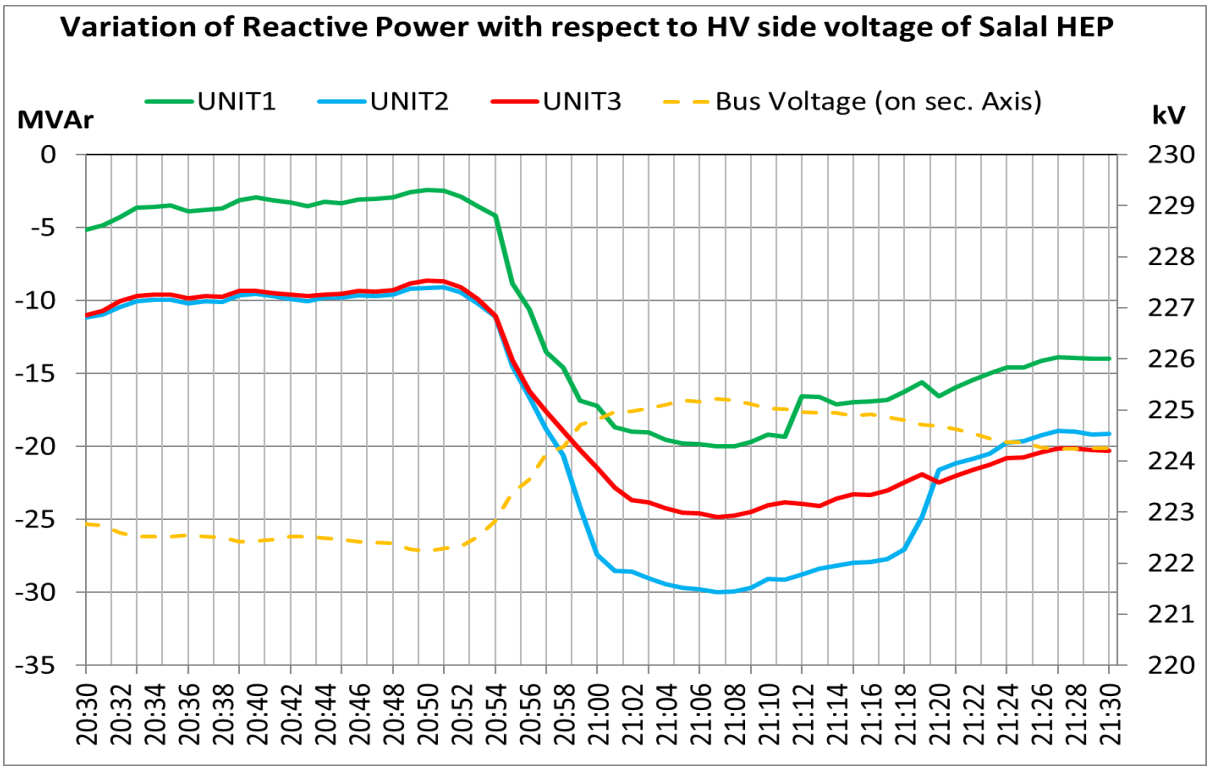
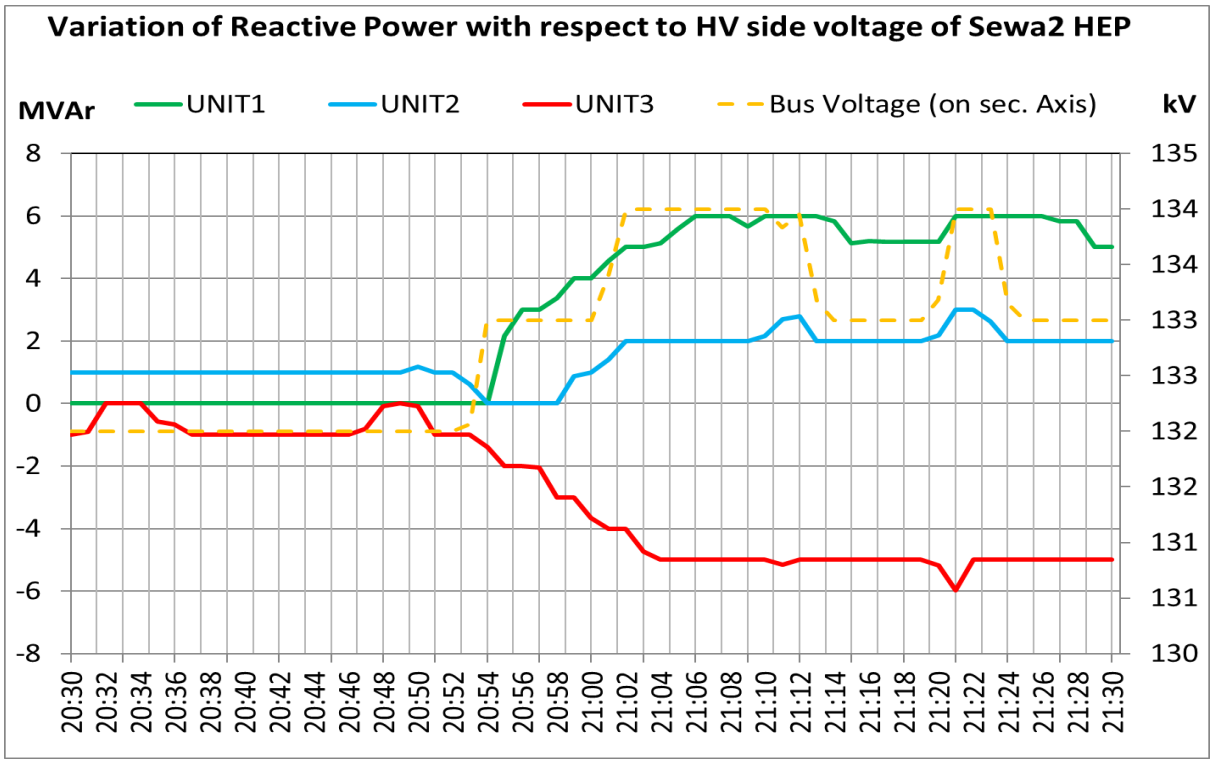
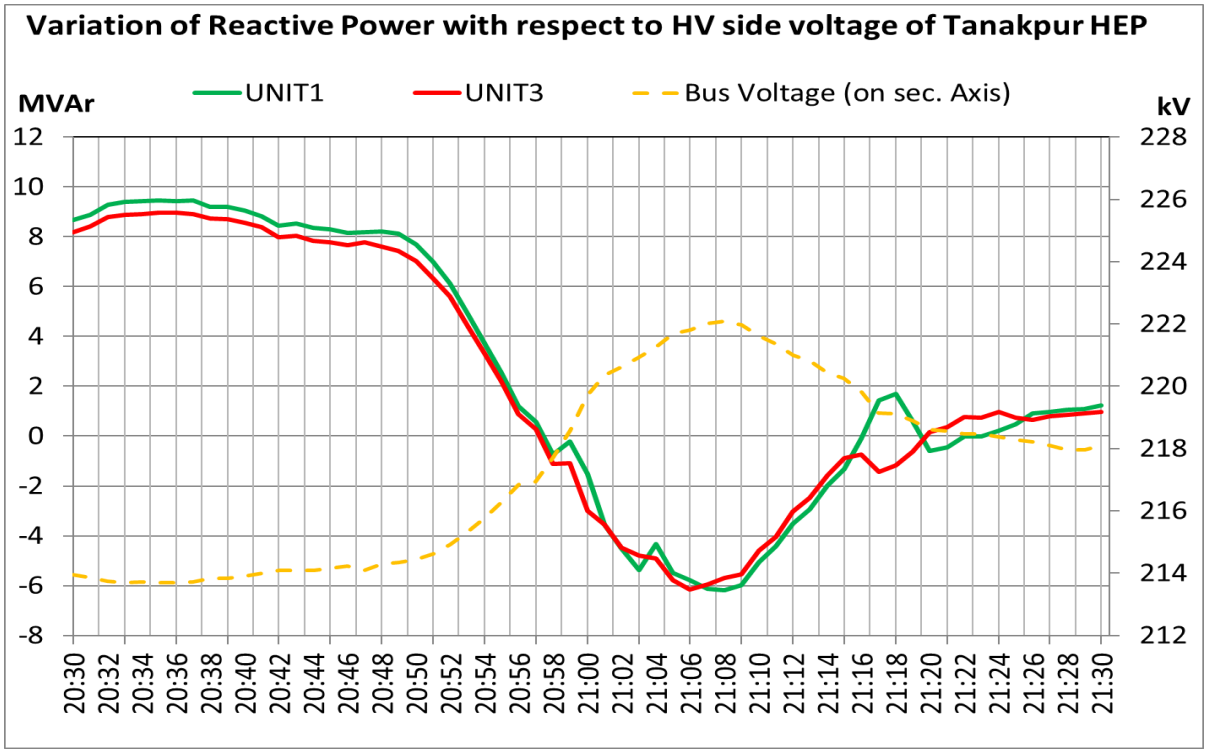
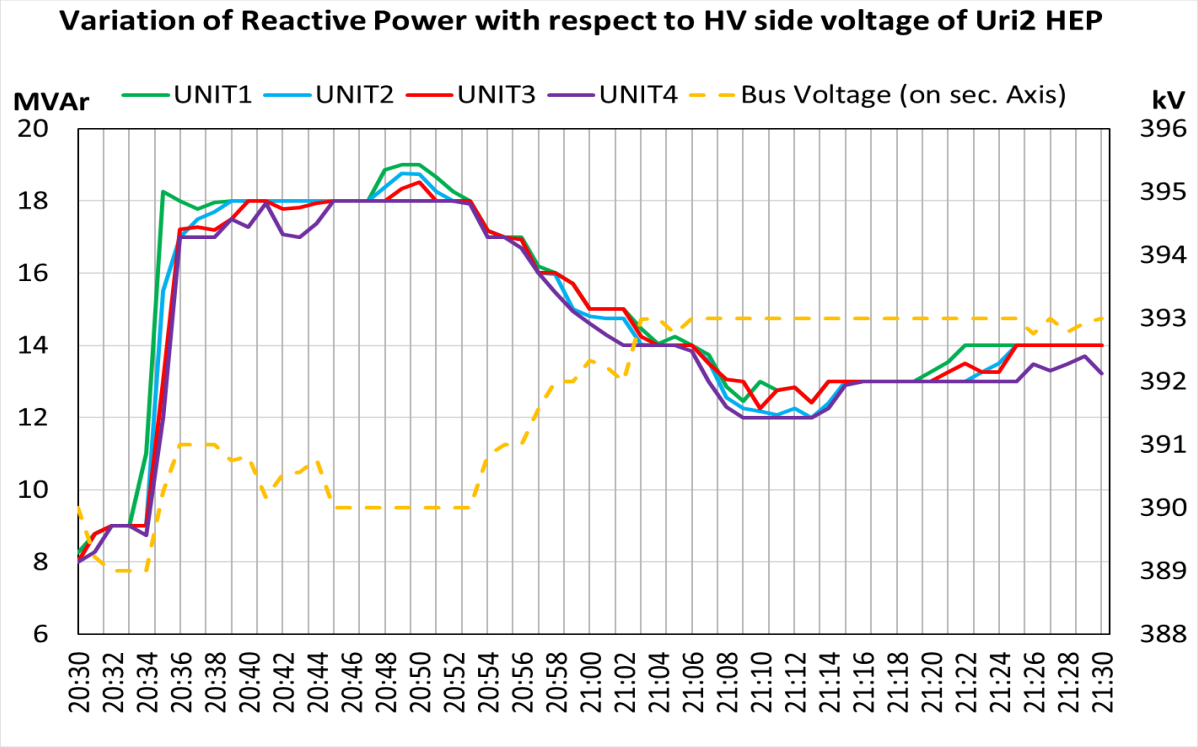
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of Parbati3 HEP
UNIT1
Bus Voltage (on sec. Axis)
MVAr
kV
20
15
10
5
0
-5
-10
-15
-20
415
410
405
400
395
390
385
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of Salal HEP
UNIT1
UNIT2
UNIT3
Bus Voltage (on sec. Axis)
MVAr
kV
0
-5
-10
-15
-20
-25
-30
-35
230
229
228
227
226
225
224
223
222
221
220
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of Sewa2 HEP
MVAr
UNIT1
UNIT2
UNIT3
Bus Voltage (on sec. Axis)
kV
8
6
4
2
0
-2
-4
-6
-8
135
134
134
133
133
132
132
131
131
130
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of Tanakpur HEP
MVAr
UNIT1
UNIT3
Bus Voltage (on sec. Axis)
kV
12
10
8
6
4
2
0
-2
-4
-6
-8
228
226
224
222
220
218
216
214
212
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of Uri2 HEP
MVAr
UNIT1
UNIT2
UNIT3
UNIT4
Bus Voltage (on sec. Axis)
kV
20
18
16
14
12
10
8
6
396
395
394
393
392
391
390
389
388
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
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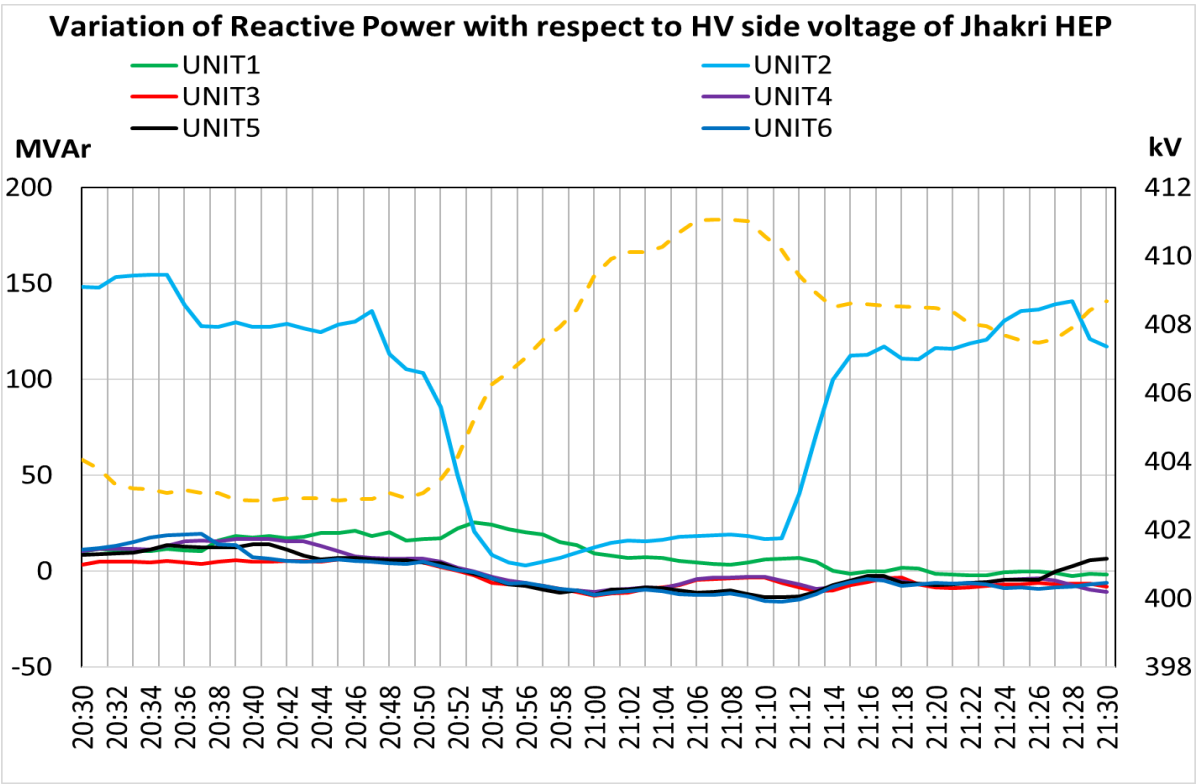
21:30


Variation of Reactive Power with respect to HV side voltage of Jhakri HEP
UNIT1
UNIT2
UNIT3
UNIT4
UNIT5
UNIT6
MVAr
kV
200
150
100
50
0
-50
412
410
408
406
404
402
400
398
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
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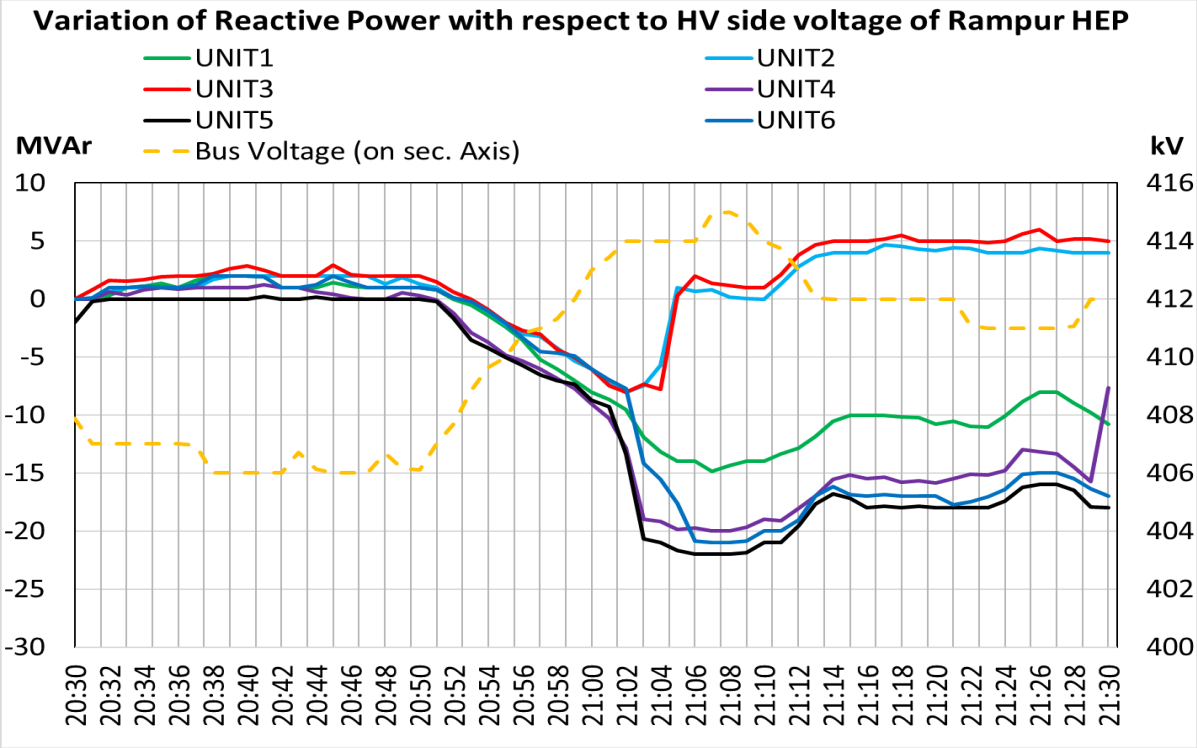
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of Rampur HEP
UNIT1
UNIT2
UNIT3
UNIT4
UNIT5
UNIT6
Bus Voltage (on sec. Axis)
MVAr
kV
10
5
0
-5
-10
-15
-20
-25
-30
416
414
412
410
408
406
404
402
400
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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21:12
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21:18
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21:22
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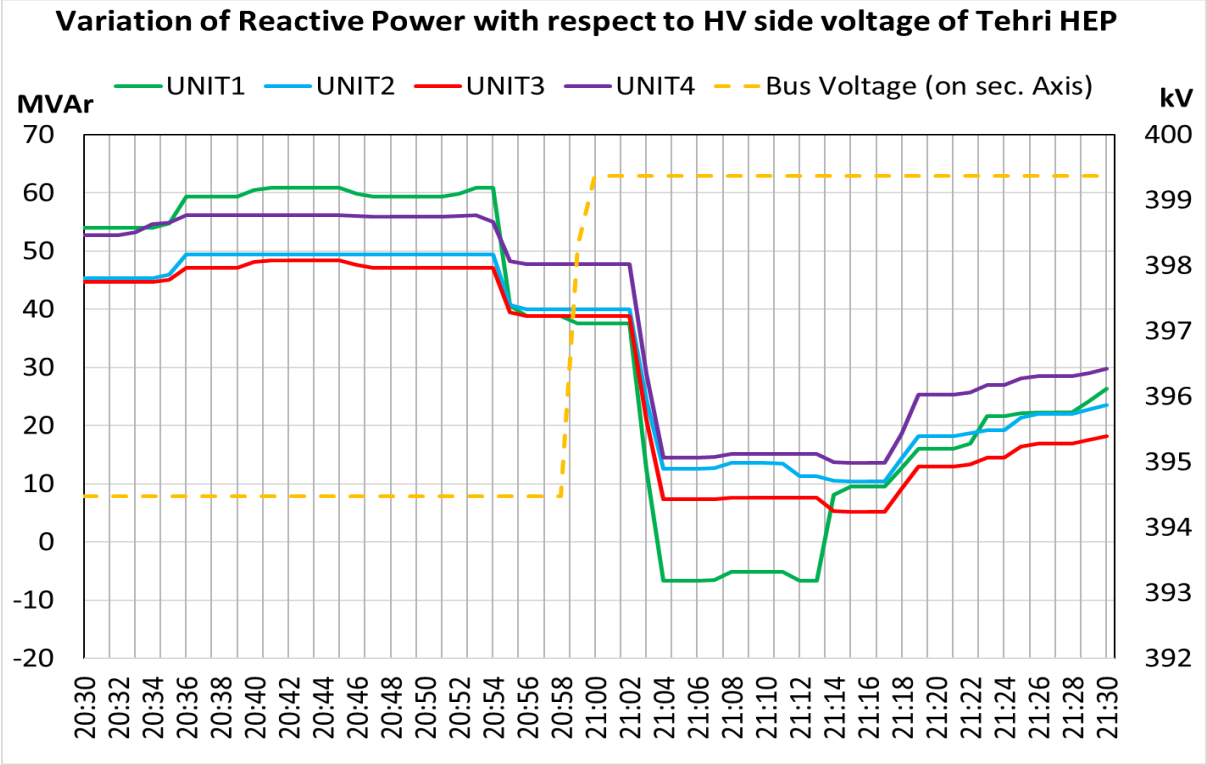
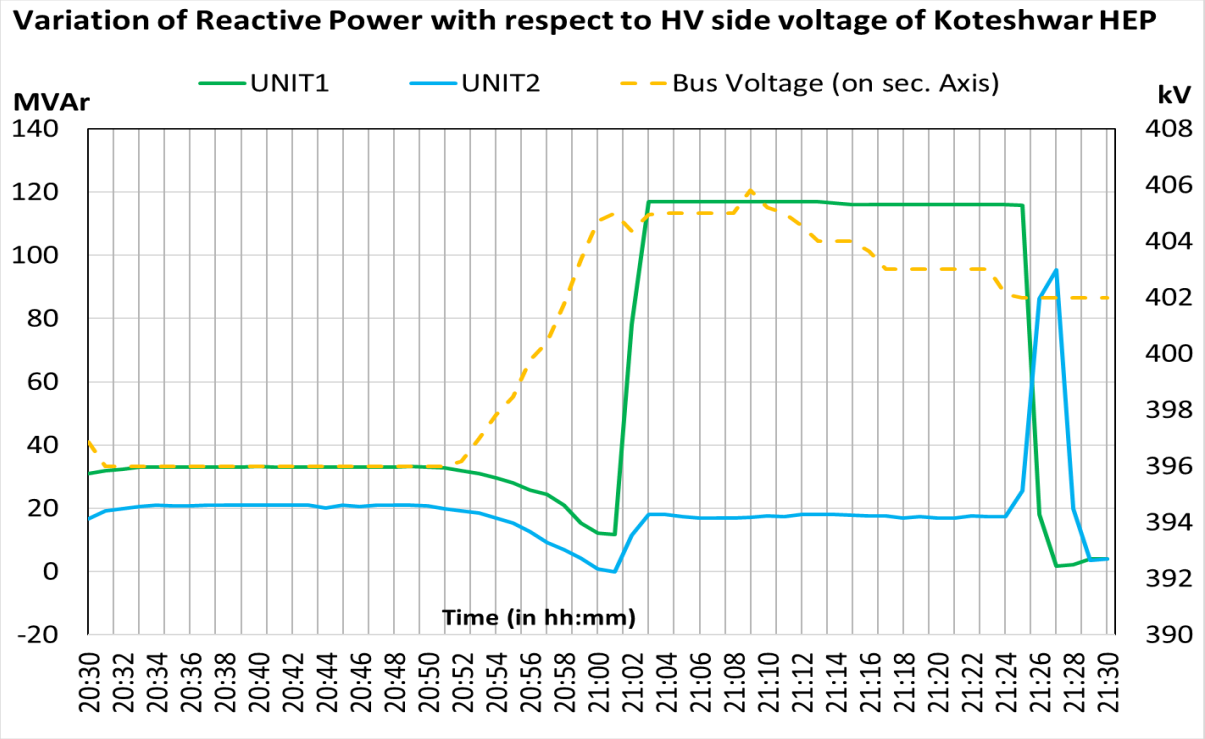
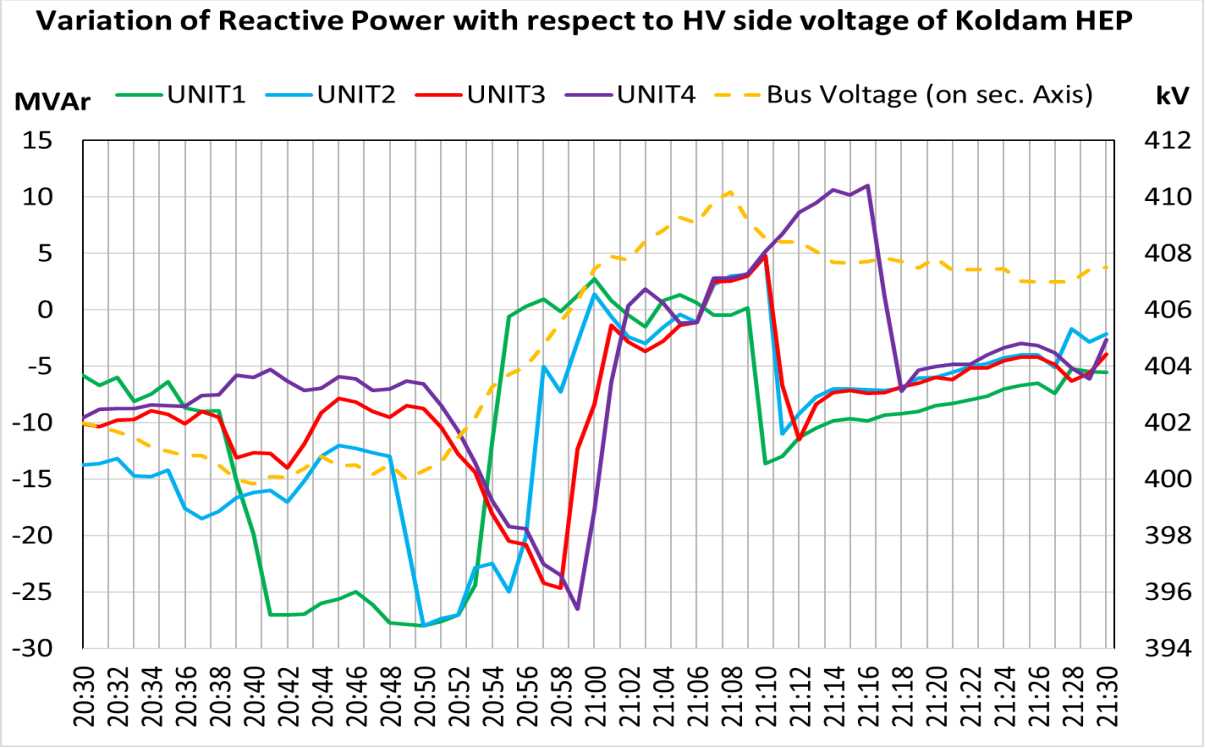
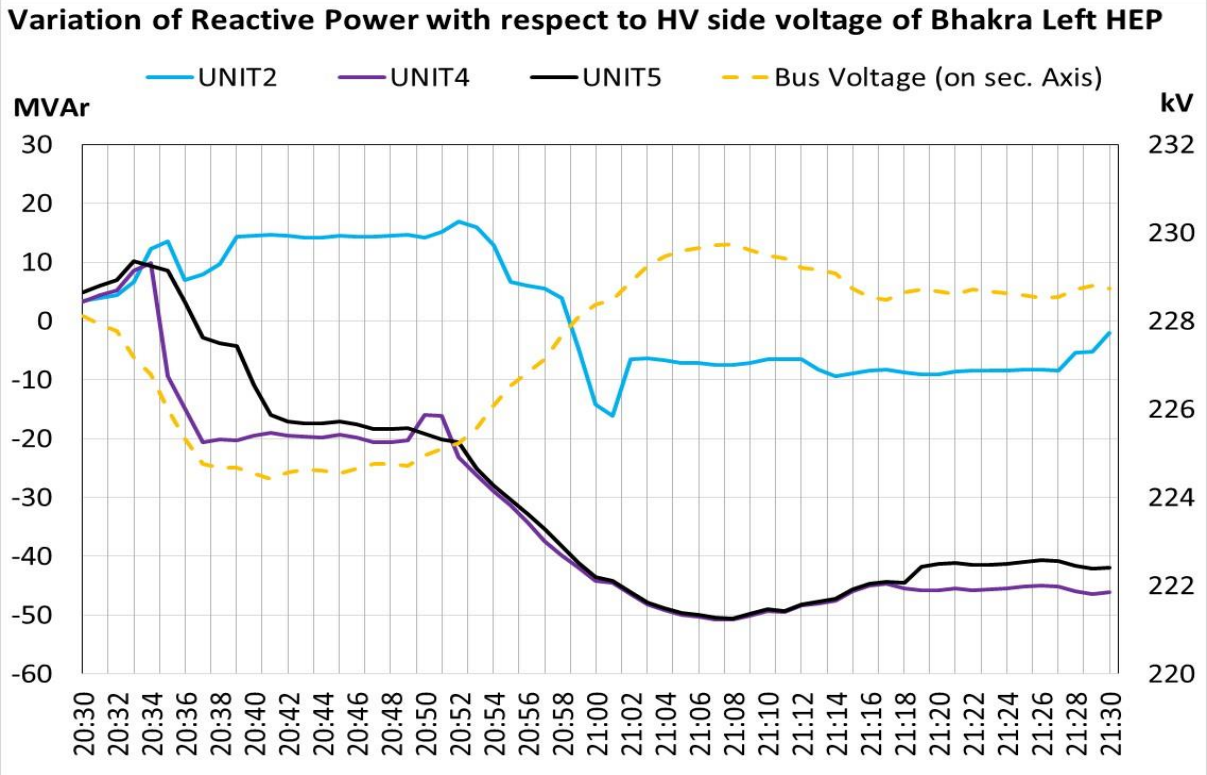
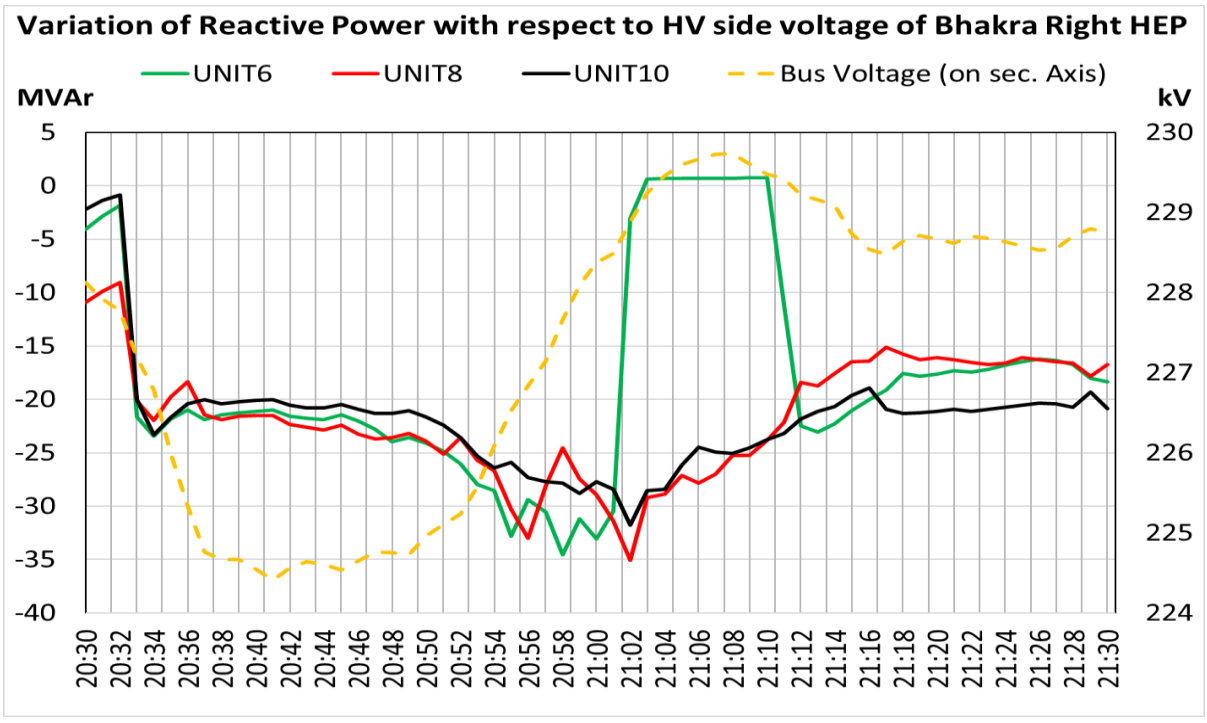
21:26
21:28
21:30

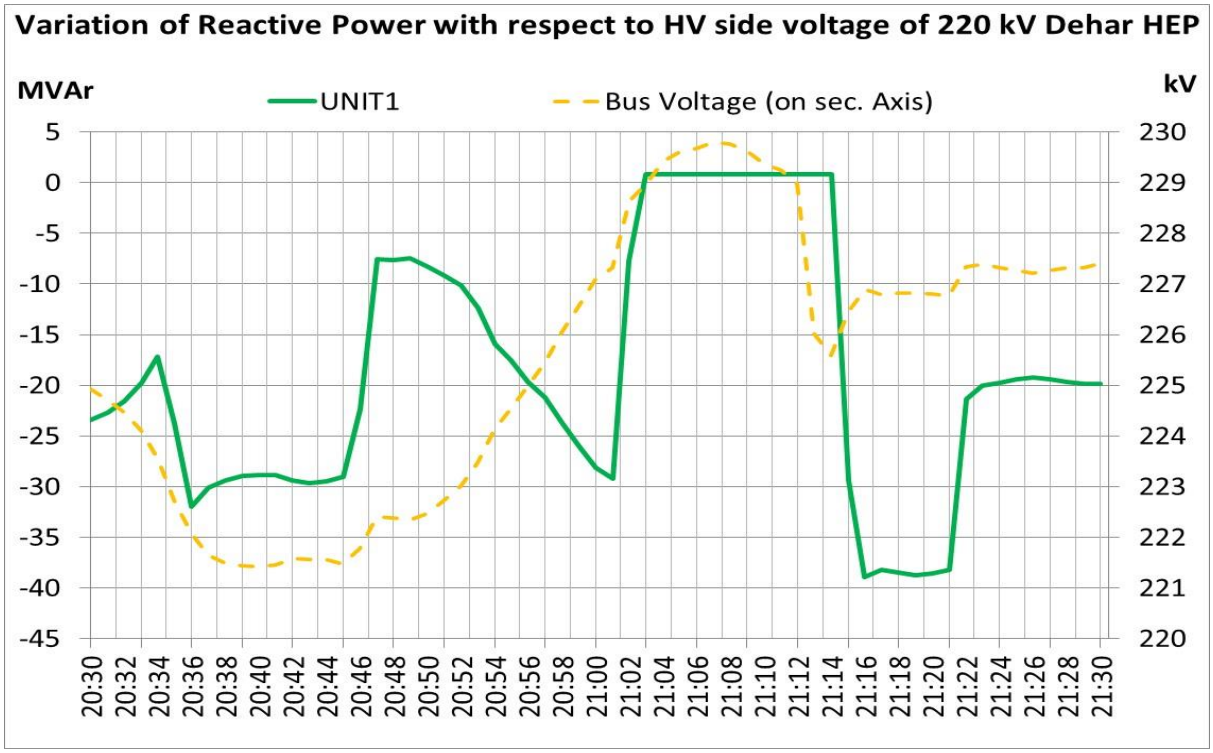

Variation of Reactive Power with respect to HV side voltage of Tehri HEP
UNIT1
UNIT2
UNIT3
UNIT4
Bus Voltage (on sec. Axis)
MVAr
kV
70
60
50
40
30
20
10
0
-10
-20
400
399
398
397
396
395
394
393
392
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

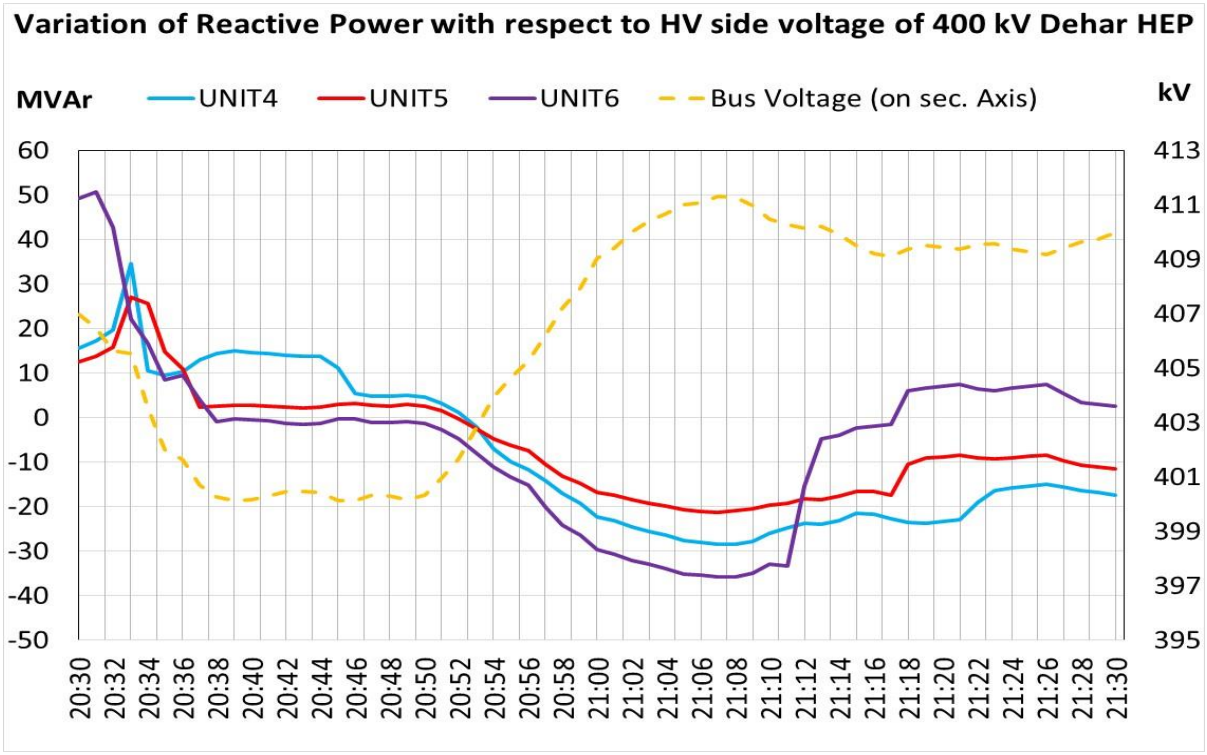

Variation of Reactive Power with respect to HV side voltage of Koteshwar HEP
UNIT1
UNIT2
Bus Voltage (on sec. Axis)
MVAr
kV
140
120
100
80
60
40
20
0
-20
408
406
404
402
400
398
396
394
392
390
Time (in hh:mm)
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

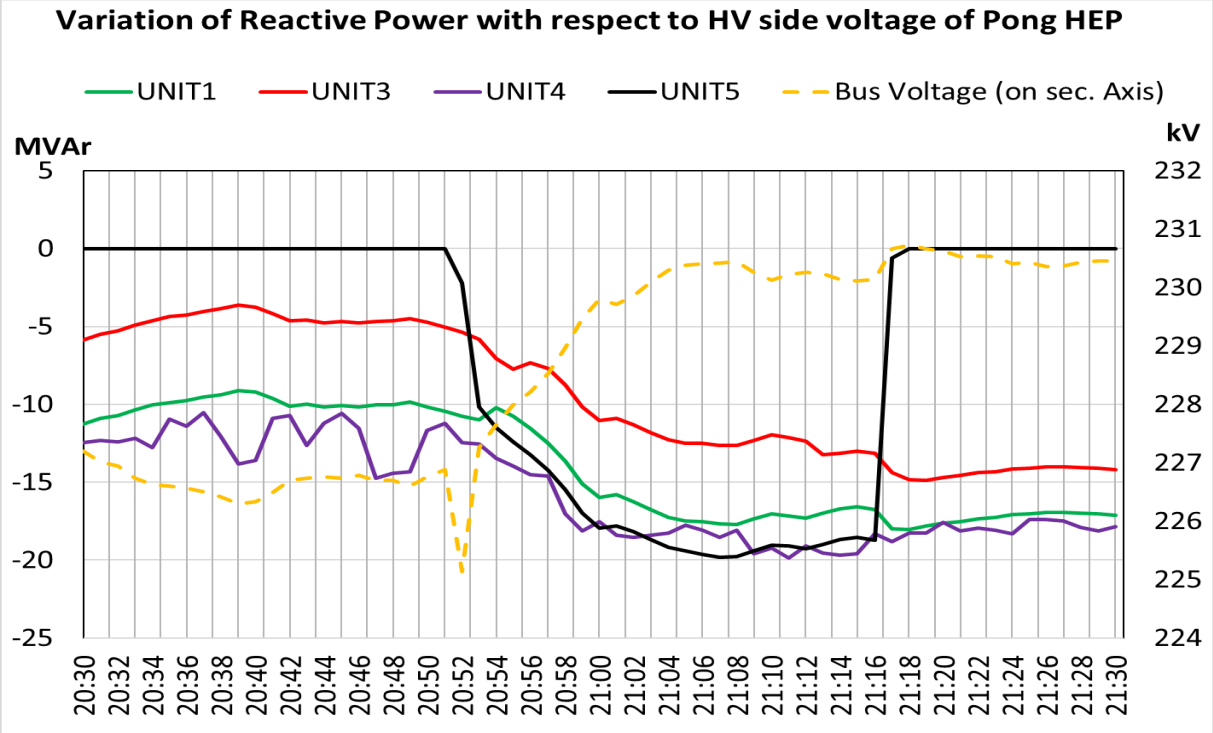

Variation of Reactive Power with respect to HV side voltage of Koldam HEP
MVAr
UNIT1
UNIT2
UNIT3
UNIT4
Bus Voltage (on sec. Axis)
kV
15
10
5
0
-5
-10
-15
-20
-25
-30
412
410
408
406
404
402
400
398
396
394
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

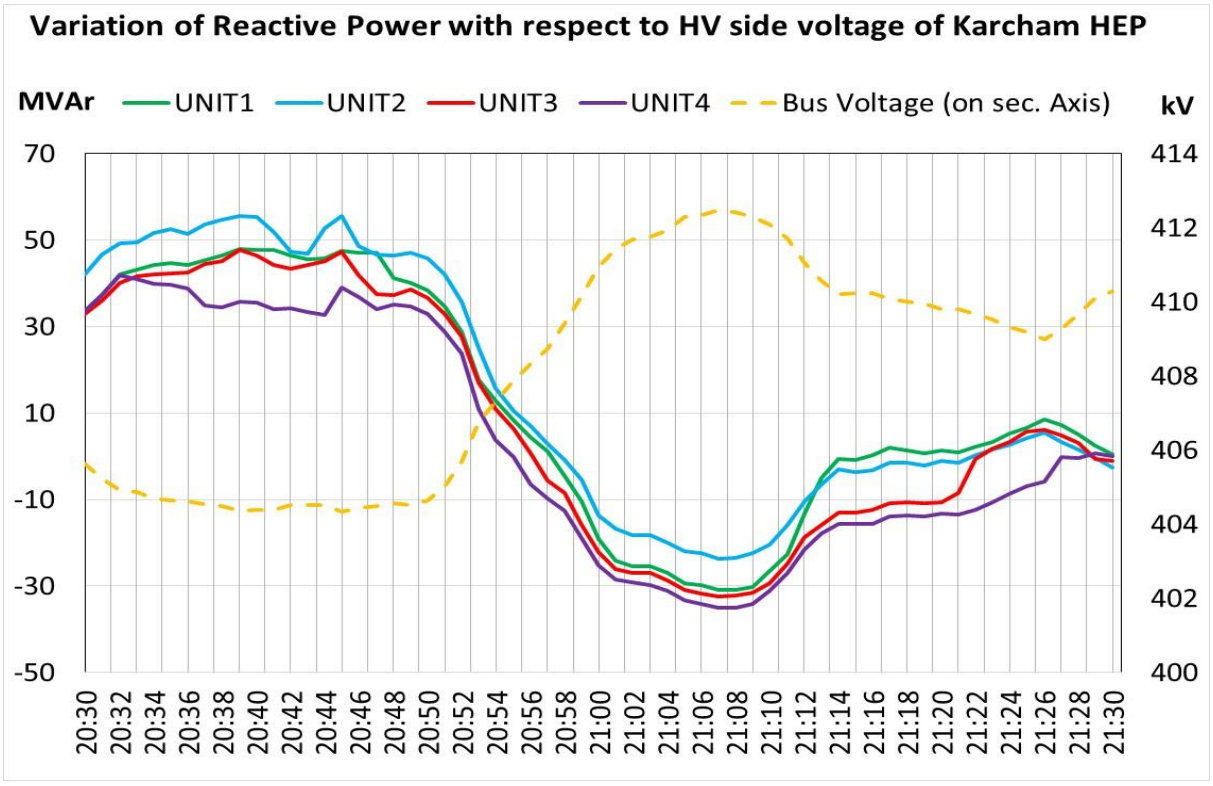

Variation of Reactive Power with respect to HV side voltage of Bhakra Left HEP
UNIT2
UNIT4
UNIT5
Bus Voltage (on sec. Axis)
MVAr
kV
30
20
10
0
-10
-20
-30
-40
-50
-60
232
230
228
226
224
222
220
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

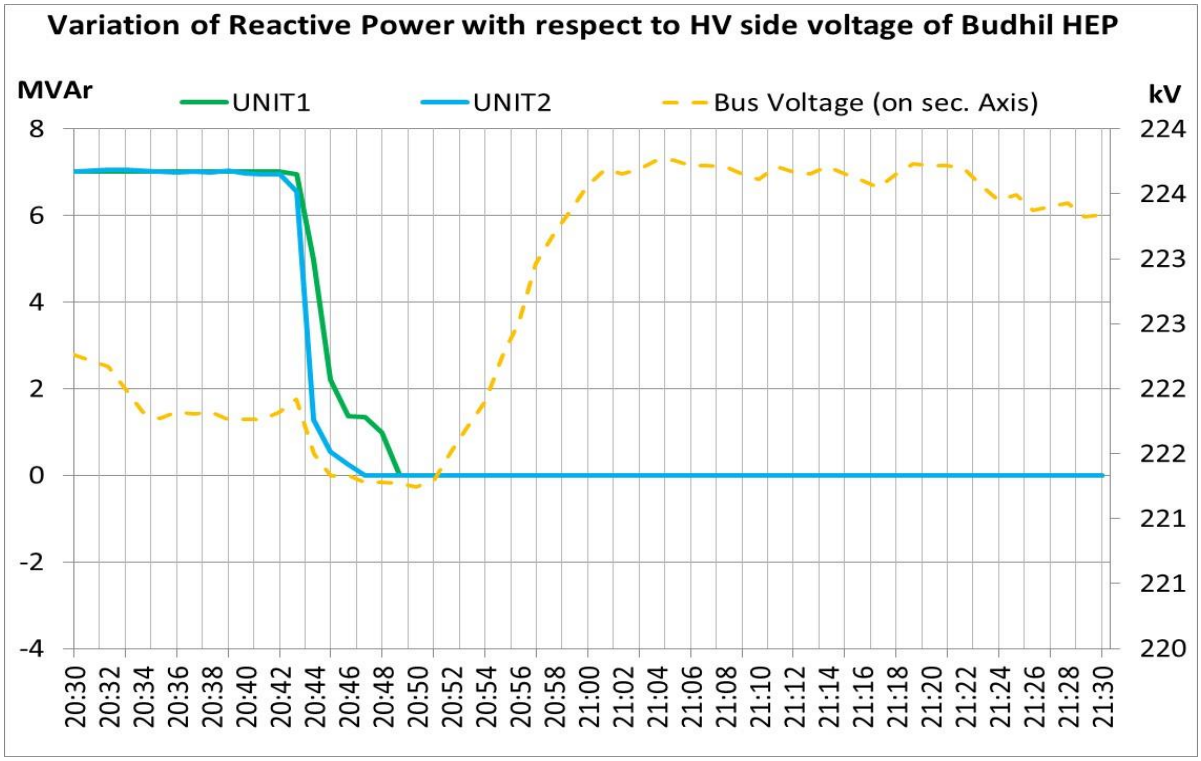

Variation of Reactive Power with respect to HV side voltage of Bhakra Right HEP
UNIT6
UNIT8
UNIT10
Bus Voltage (on sec. Axis)
MVAr
kV
5
0
-5
-10
-15
-20
-25
-30
-35
-40
230
229
228
227
226
225
224
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of 220 kV Dehar HEP
MVAr
kV
UNIT1
Bus Voltage (on sec. Axis)
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
230
229
228
227
226
225
224
223
222
221
220
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

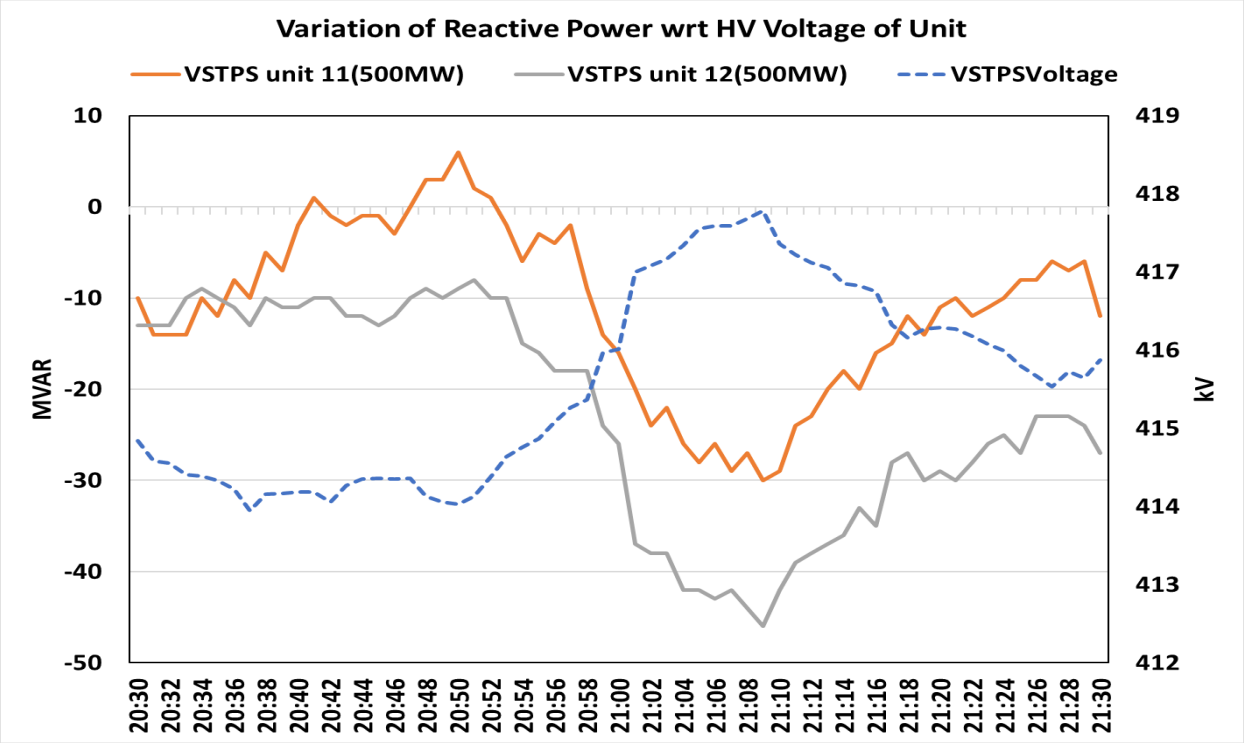

Variation of Reactive Power with respect to HV side voltage of 400 kV Dehar HEP
MVAr
kV
UNIT4
UNIT5
UNIT6
Bus Voltage (on sec. Axis)
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
413
411
409
407
405
403
401
399
397
395
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

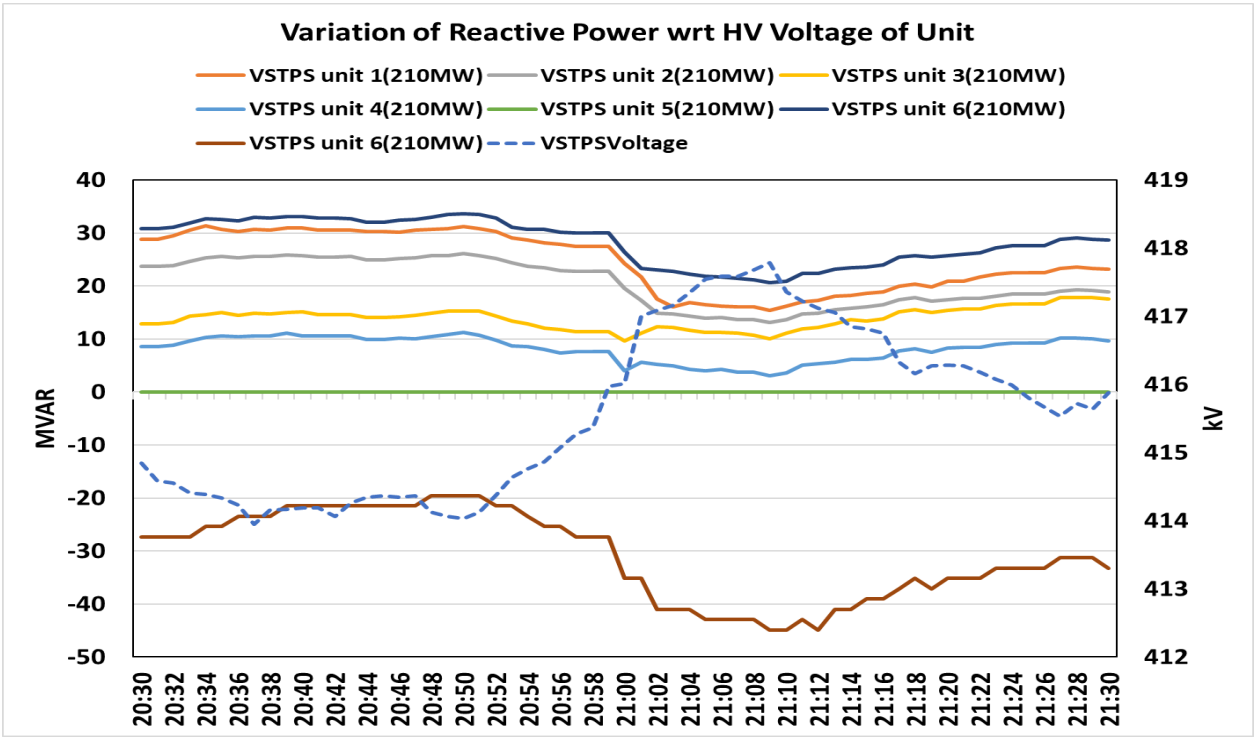

Variation of Reactive Power with respect to HV side voltage of Pong HEP
UNIT1
UNIT3
UNIT4
UNIT5
Bus Voltage (on sec. Axis)
MVAr
kV
5
0
-5
-10
-15
-20
-25
232
231
230
229
228
227
226
225
224
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

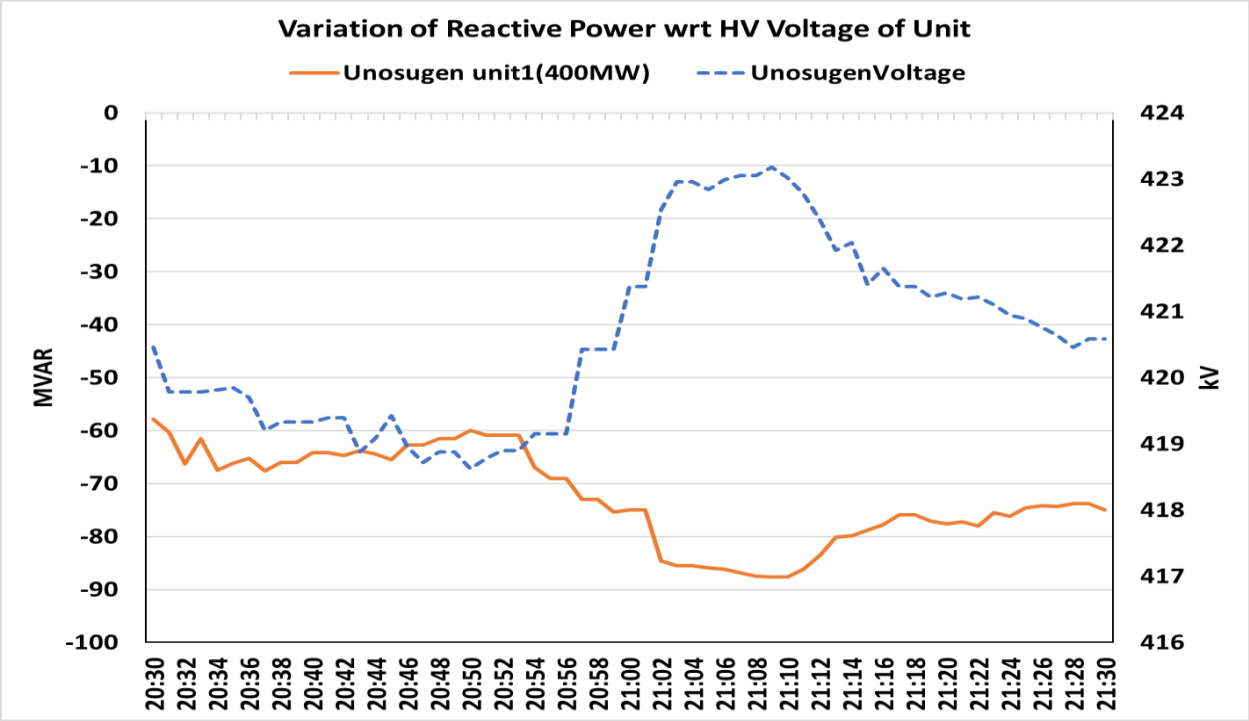

Variation of Reactive Power with respect to HV side voltage of Karcham HEP
MVAr
UNIT1
UNIT2
UNIT3
UNIT4
Bus Voltage (on sec. Axis)
kV
70
50
30
10
-10
-30
-50
414
412
410
408
406
404
402
400
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

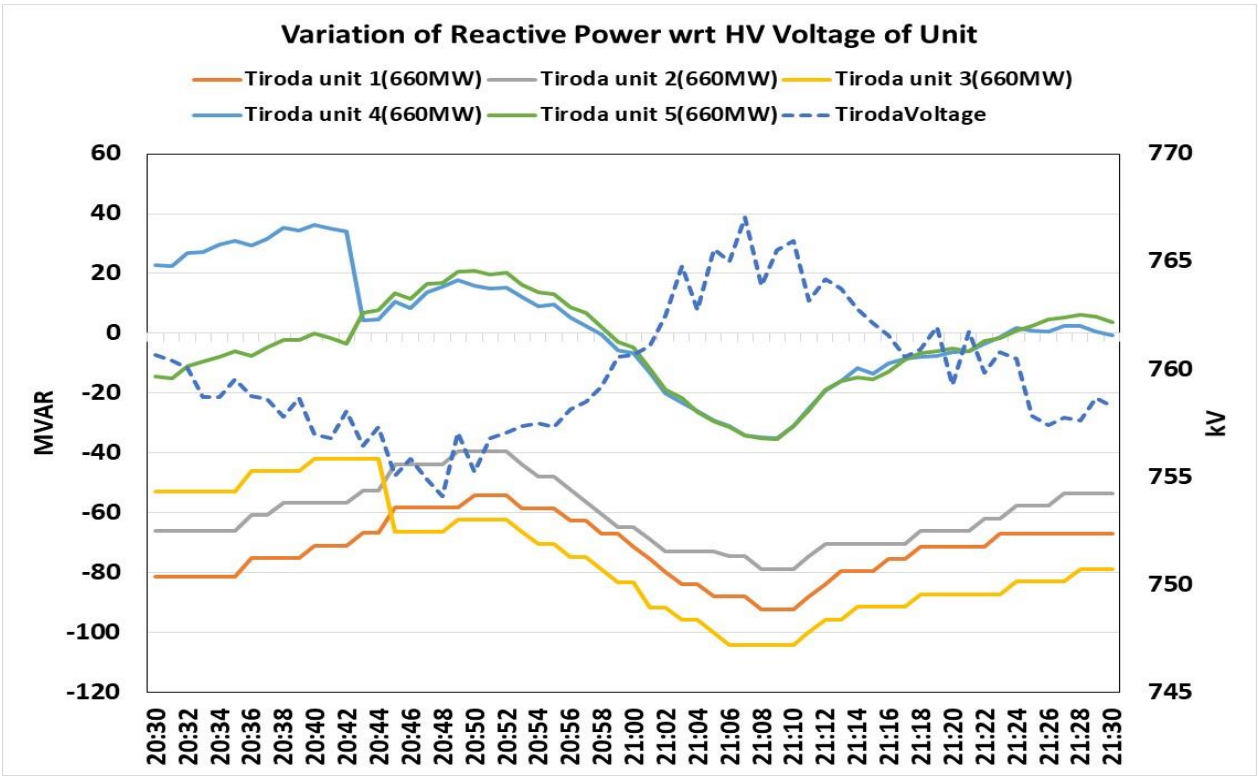

Variation of Reactive Power with respect to HV side voltage of Budhil HEP
MVAr
kV
UNIT1
UNIT2
Bus Voltage (on sec. Axis)
8
6
4
2
0
-2
-4
224
224
223
223
222
222
221
221
220
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

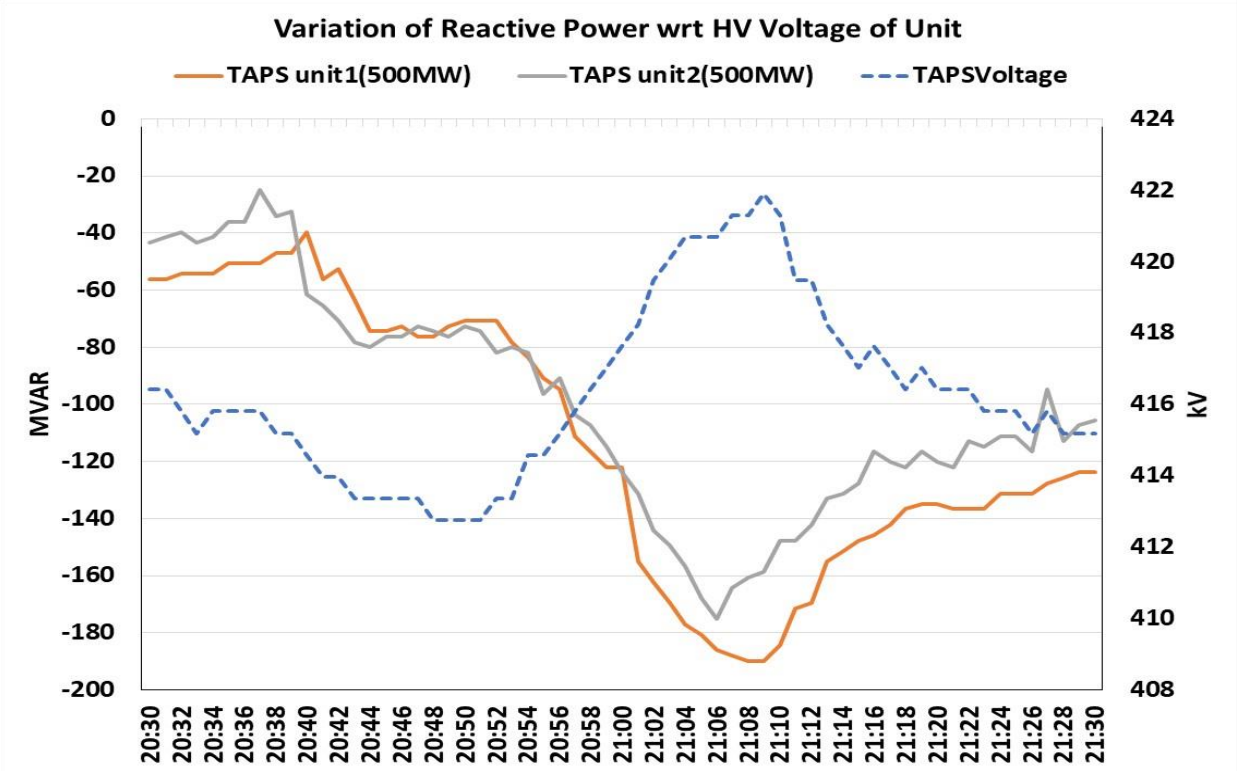
Western Region

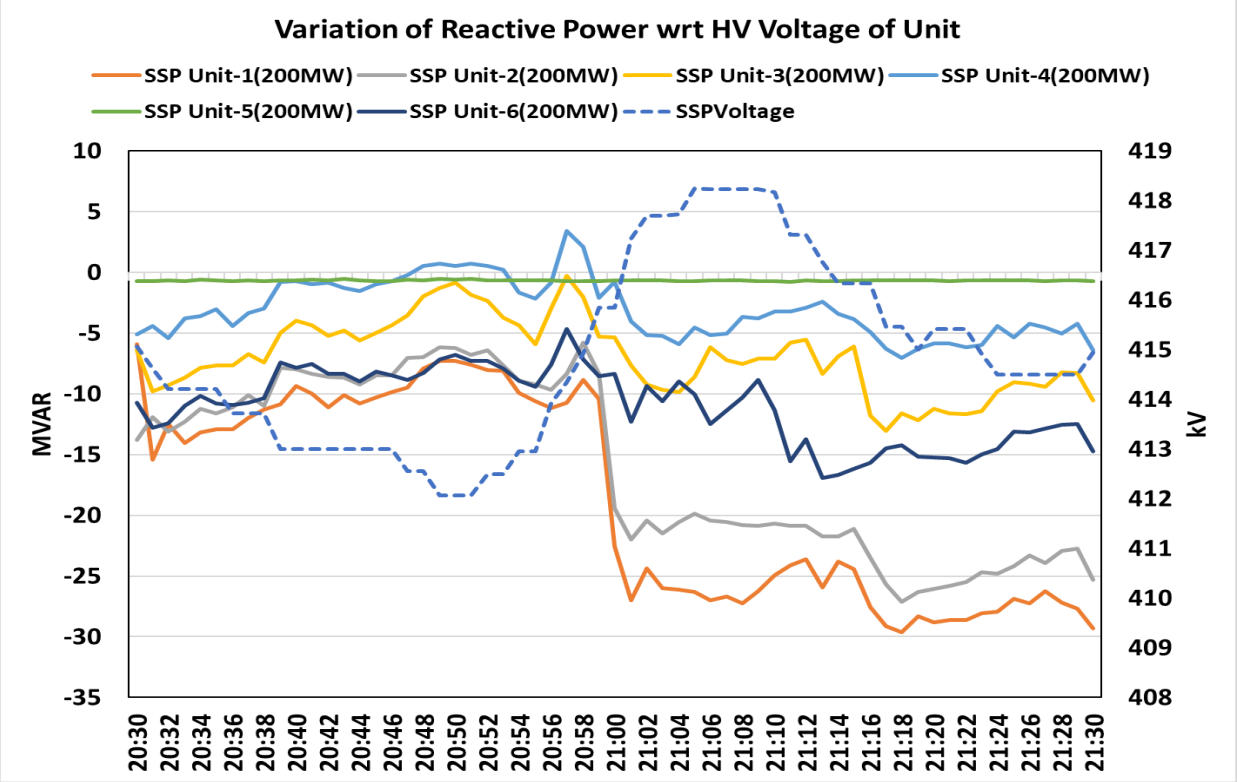


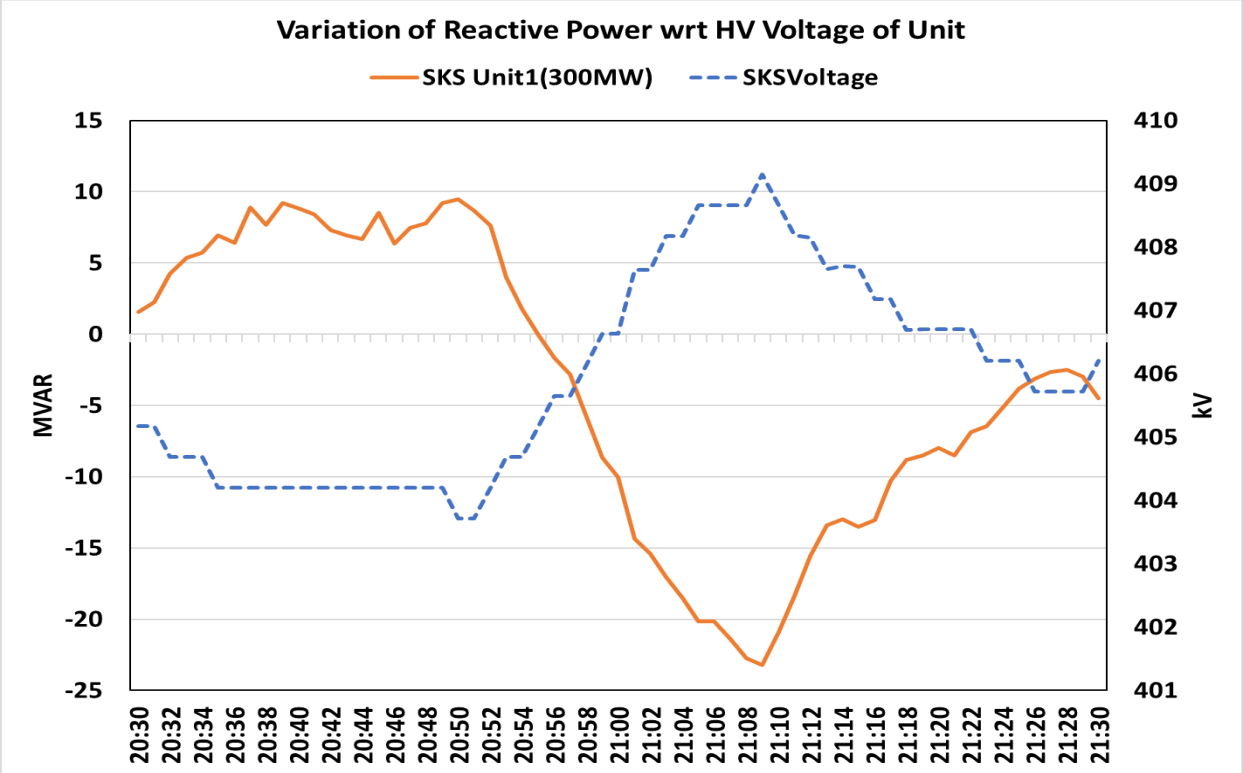


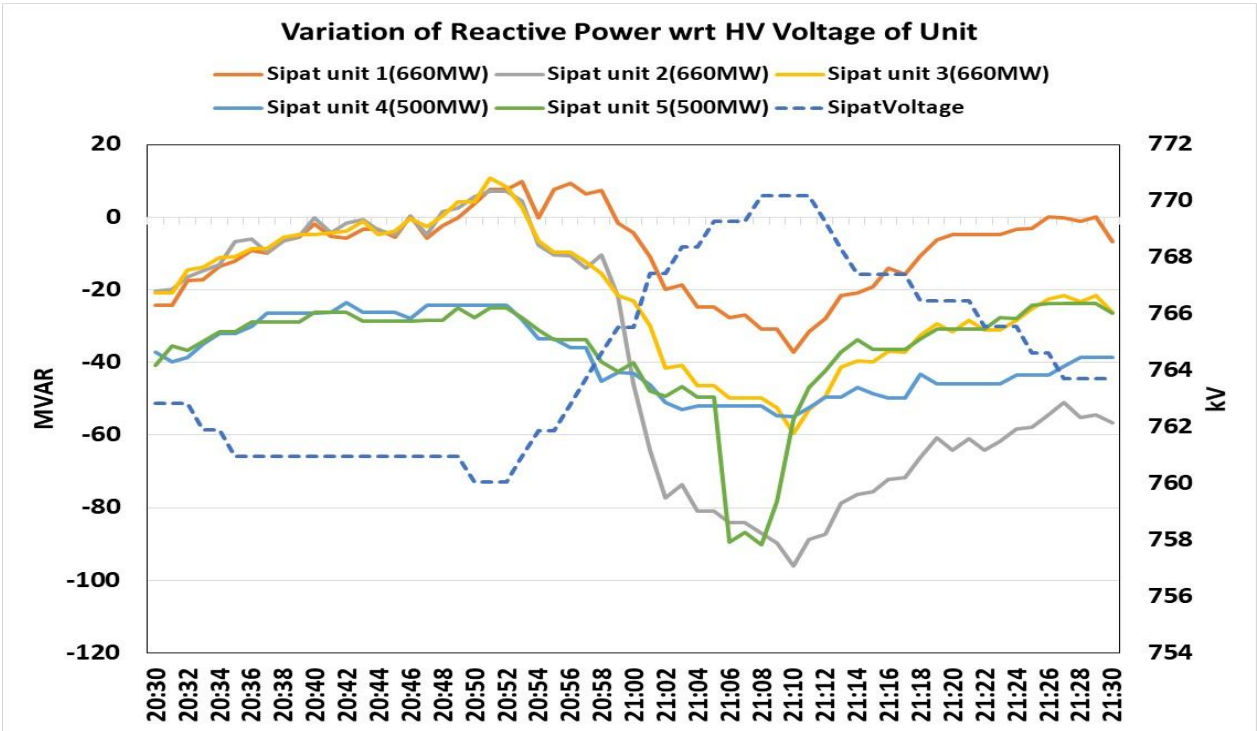

Variation of Reactive Power wrt HV Voltage of Unit
Unosugen unit1(400MW)
UnosugenVoltage
MVAR
kV
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
424
423
422
421
420
419
418
417
416
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power wrt HV Voltage of Unit
Tiroda unit 1(660MW)
Tiroda unit 2(660MW)
Tiroda unit 3(660MW)
Tiroda unit 4(660MW)
Tiroda unit 5(660MW)
TirodaVoltage
MVAR
kV
60
40
20
0
-20
-40
-60
-80
-100
-120
770
765
760
755
750
745
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power wrt HV Voltage of Unit
TAPS unit1(500MW)
TAPS unit2(500MW)
TAPSVoltage
MVAR
kV
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
424
422
420
418
416
414
412
410
408
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power wrt HV Voltage of Unit
SSP Unit-1(200MW)
SSP Unit-2(200MW)
SSP Unit-3(200MW)
SSP Unit-4(200MW)
SSP Unit-5(200MW)
SSP Unit-6(200MW)
SSPVoltage
MVAR
kV
10
5
0
-5
-10
-15
-20
-25
-30
-35
419
418
417
416
415
414
413
412
411
410
409
408
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power wrt HV Voltage of Unit
SKS Unit1(300MW)
SKSVoltage
MVAR
kV
15
10
5
0
-5
-10
-15
-20
-25
410
409
408
407
406
405
404
403
402
401
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power wrt HV Voltage of Unit
Sipat unit 1(660MW)
Sipat unit 2(660MW)
Sipat unit 3(660MW)
Sipat unit 4(500MW)
Sipat unit 5(500MW)
SipatVoltage
MVAR
kV
20
0
-20
-40
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-120
772
770
768
766
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762
760
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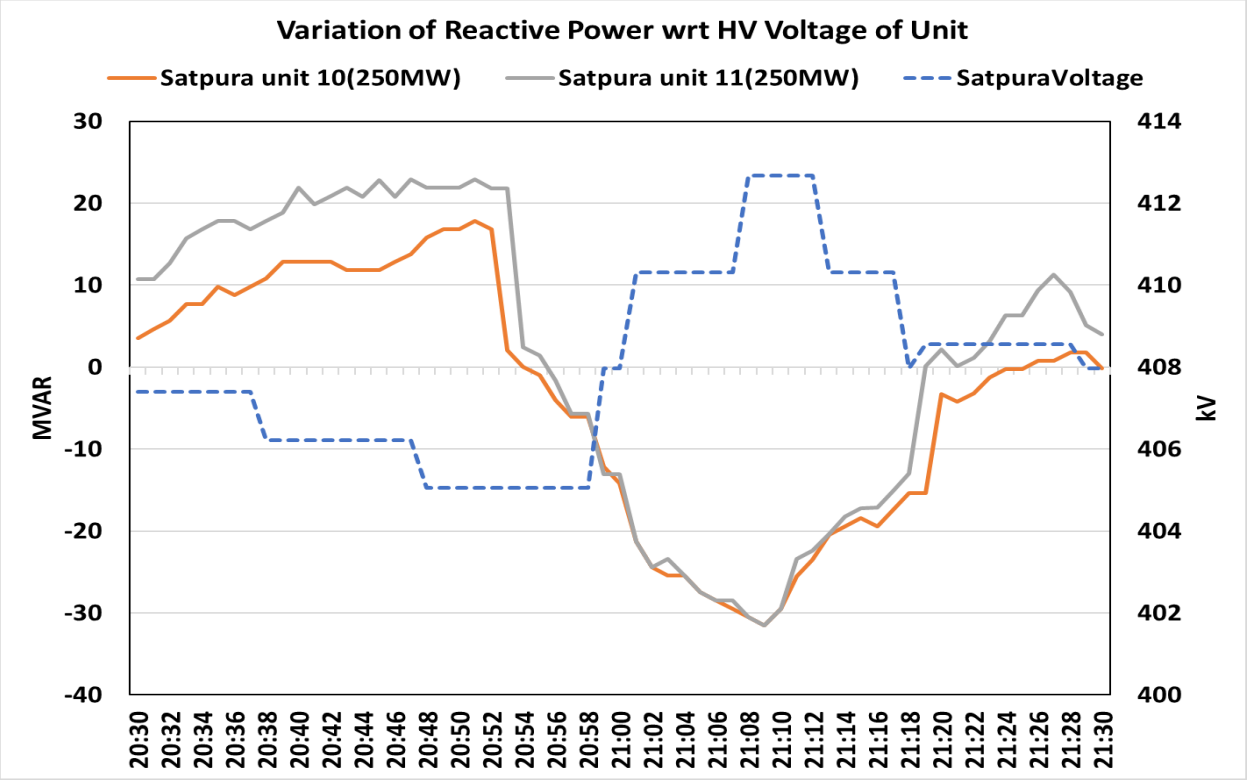
Variation of Reactive Power wrt HV Voltage of Unit
Satpura unit 10(250MW)
Satpura unit 11(250MW)
SatpuraVoltage
MVAR
kV
30
20
10
0
-10
-20
-30
-40
414
412
410
408
406
404
402
400
20:30
20:32
20:34
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20:38
20:40
20:42
20:44
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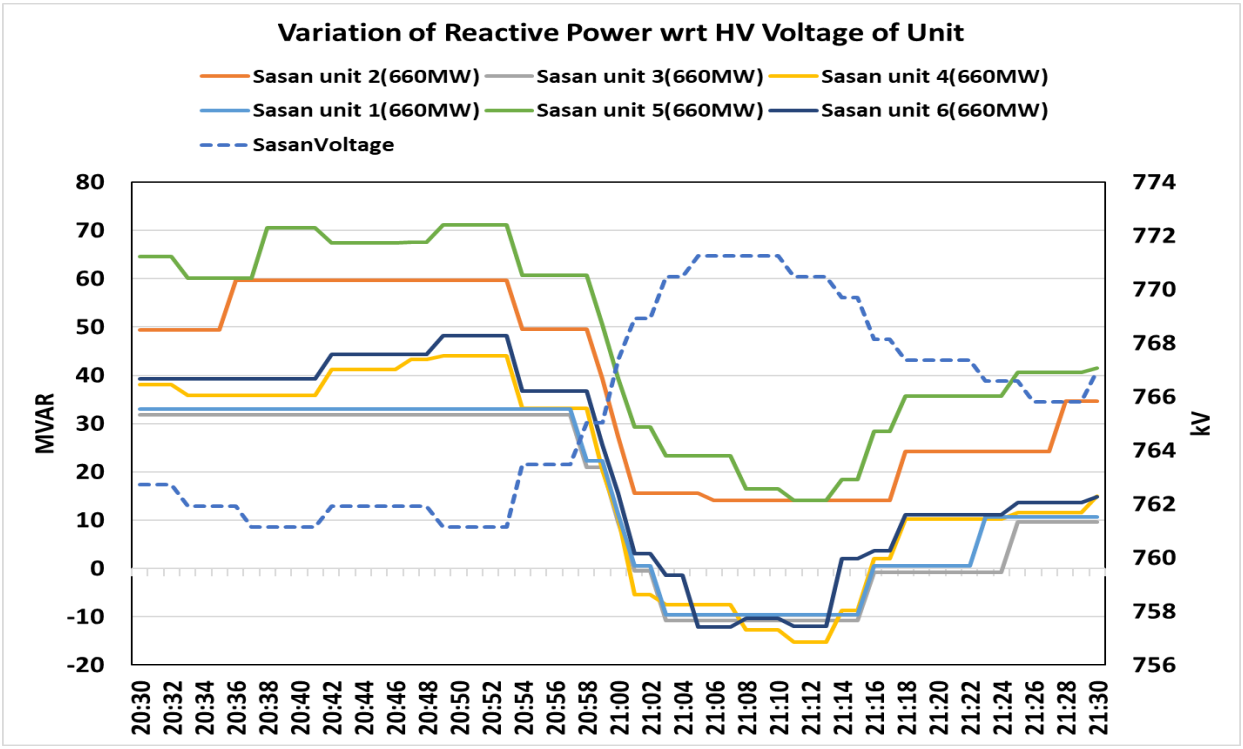
Variation of Reactive Power wrt HV Voltage of Unit
Sasan unit 2(660MW)
Sasan unit 3(660MW)
Sasan unit 4(660MW)
Sasan unit 1(660MW)
Sasan unit 5(660MW)
Sasan unit 6(660MW)
SasanVoltage
MVAR
kV
80
70
60
50
40
30
20
10
0
-10
-20
774
772
770
768
766
764
762
760
758
756
20:30
20:32
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20:42
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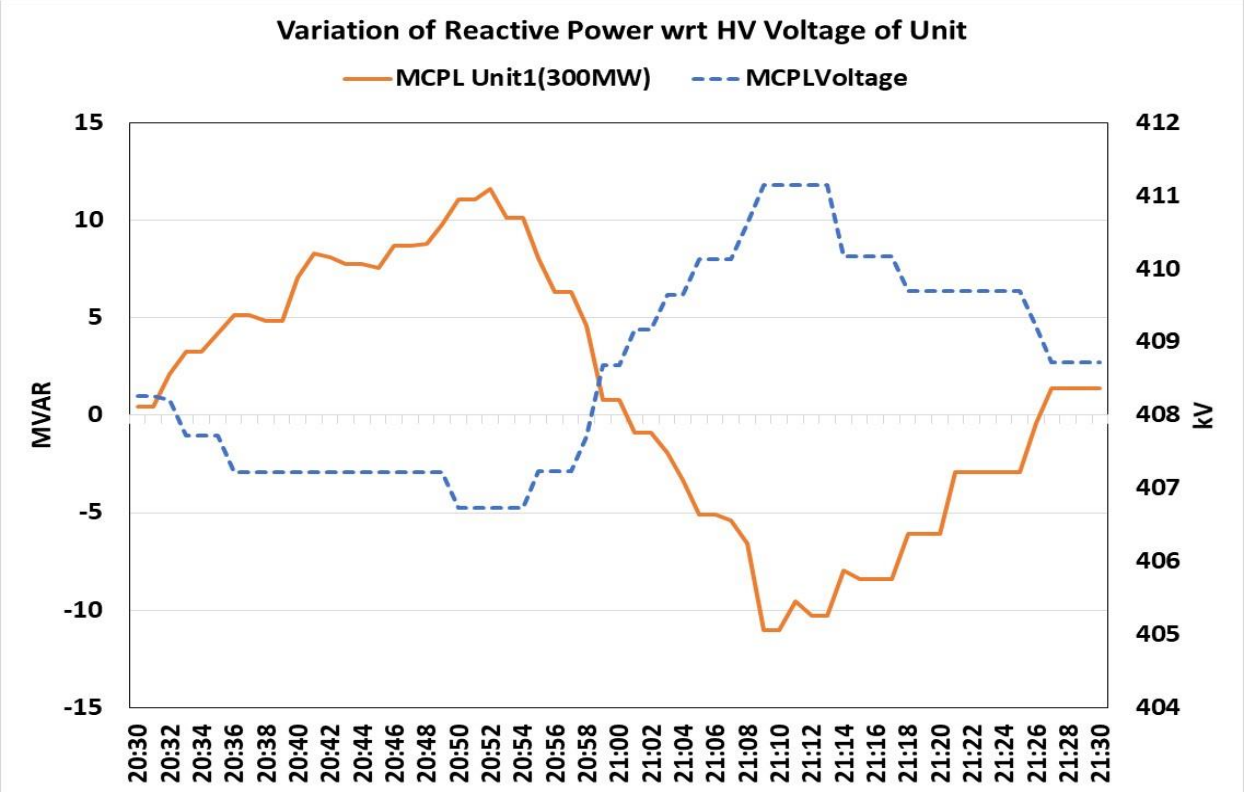
Variation of Reactive Power wrt HV Voltage of Unit
MCPL Unit1(300MW)
MCPLVoltage
MVAR
kV
15
10
5
0
-5
-10
-15
412
411
410
409
408
407
406
405
404
20:30
20:32
20:34
20:36
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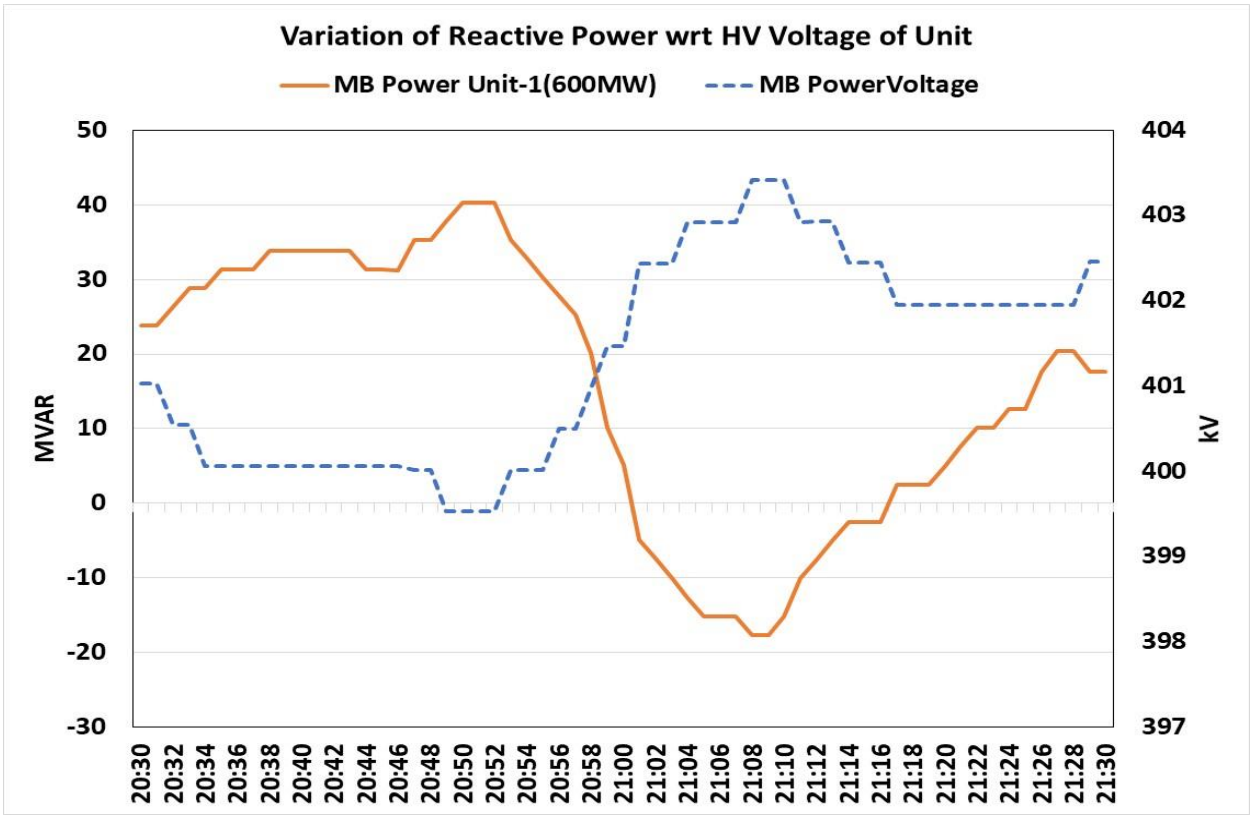
Variation of Reactive Power wrt HV Voltage of Unit
MB Power Unit-1(600MW)
MB PowerVoltage
MVAR
kV
50
40
30
20
10
0
-10
-20
-30
404
403
402
401
400
399
398
397
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
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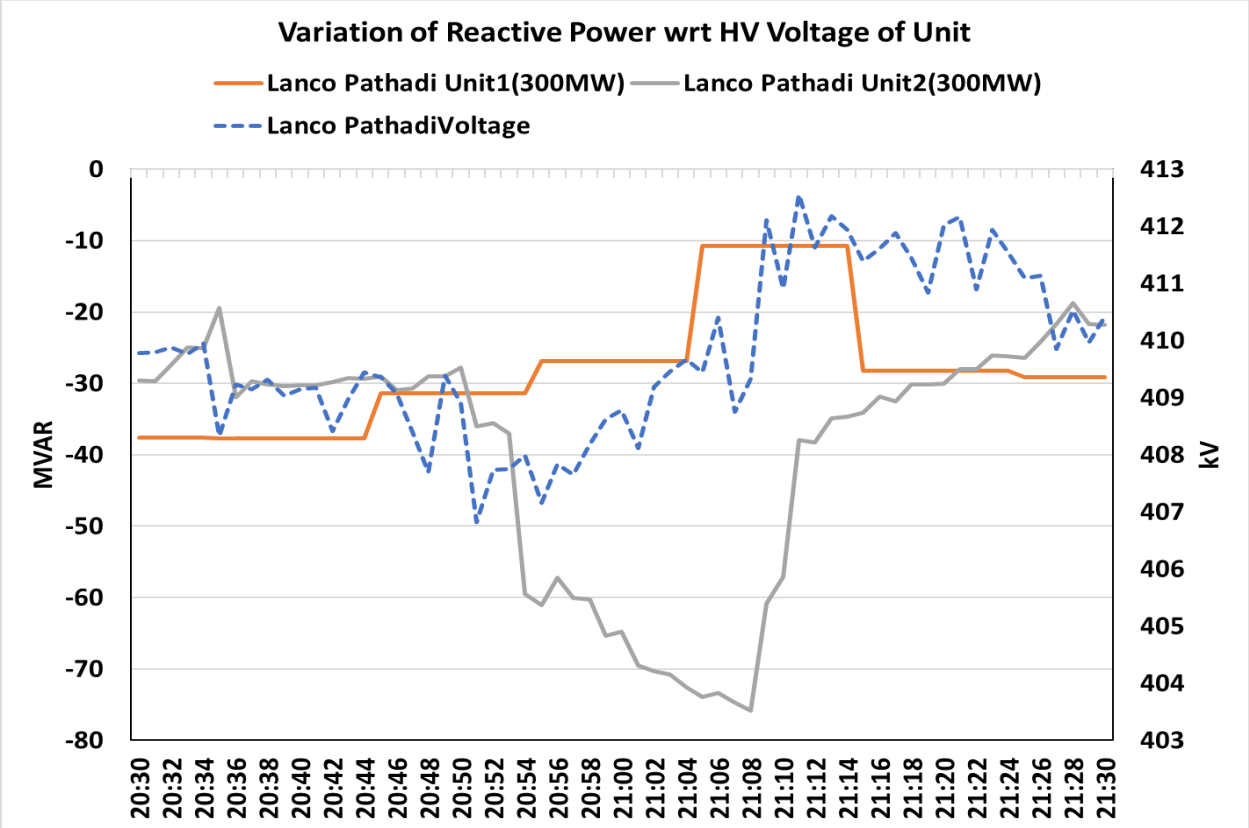
Variation of Reactive Power wrt HV Voltage of Unit
Lanco Pathadi Unit1(300MW)
Lanco Pathadi Unit2(300MW)
Lanco PathadiVoltage
MVAR
kV
0
-10
-20
-30
-40
-50
-60
-70
-80
413
412
411
410
409
408
407
406
405
404
403
20:30
20:32
20:34
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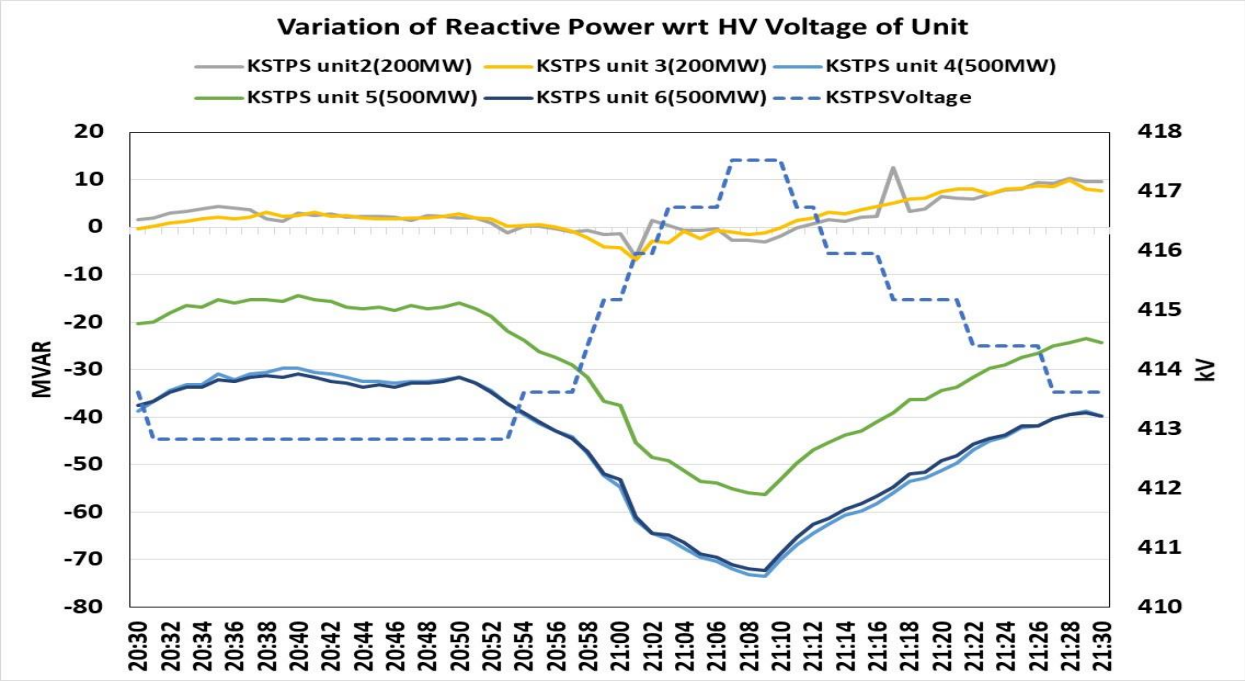
Variation of Reactive Power wrt HV Voltage of Unit
KSTPS unit2(200MW)
KSTPS unit 3(200MW)
KSTPS unit 4(500MW)
KSTPS unit 5(500MW)
KSTPS unit 6(500MW)
KSTPSVoltage
MVAR
kV
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
418
417
416
415
414
413
412
411
410
20:30
20:32
20:34
20:36
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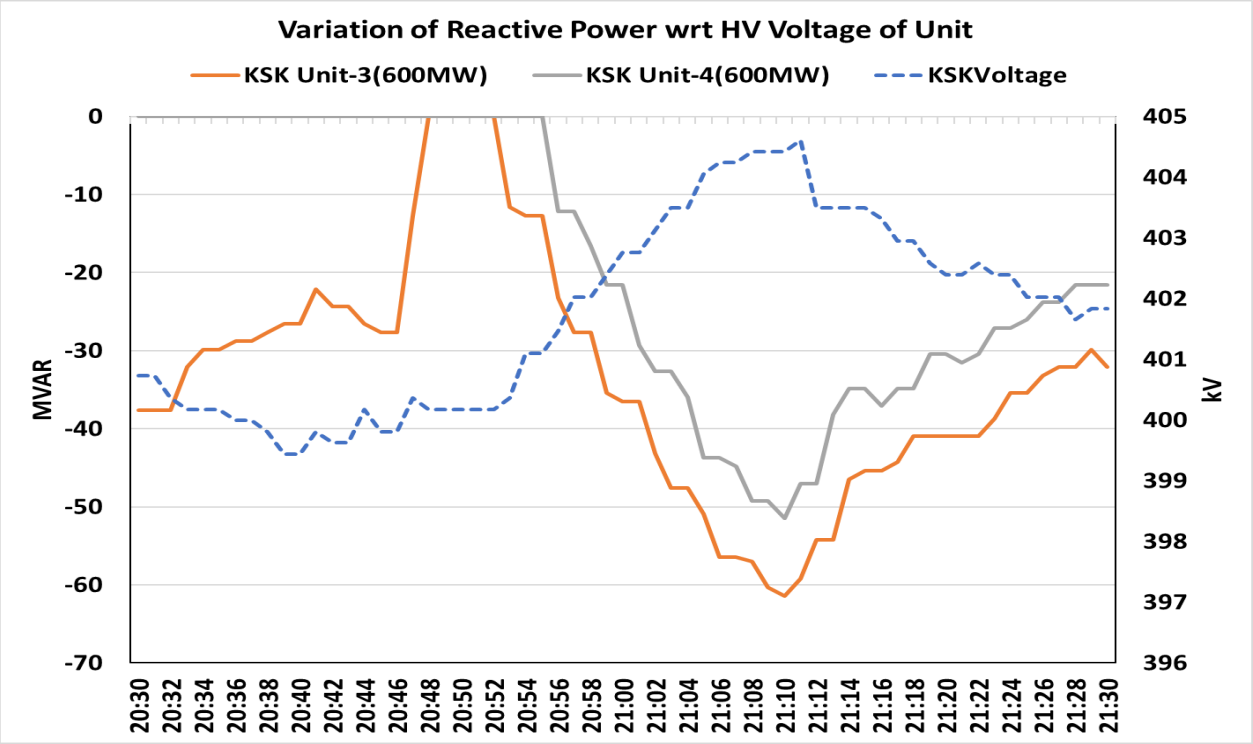
Variation of Reactive Power wrt HV Voltage of Unit
KSK Unit-3(600MW)
KSK Unit-4(600MW)
KSKVoltage
MVAR
kV
0
-10
-20
-30
-40
-50
-60
-70
405
404
403
402
401
400
399
398
397
396
20:30
20:32
20:34
20:36
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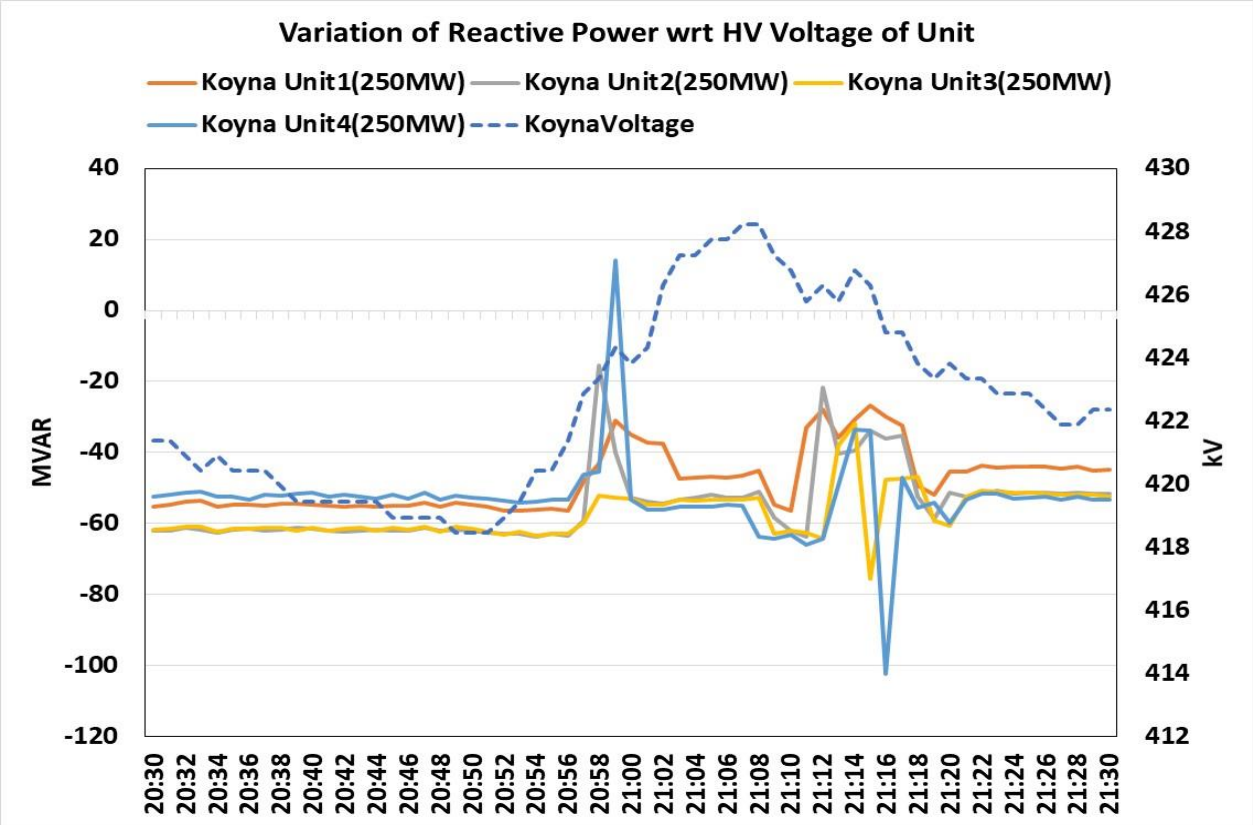
Variation of Reactive Power wrt HV Voltage of Unit
Koyna Unit1(250MW)
Koyna Unit2(250MW)
Koyna Unit3(250MW)
Koyna Unit4(250MW)
KoynaVoltage
MVAR
kV
40
20
0
-20
-40
-60
-80
-100
-120
430
428
426
424
422
420
418
416
414
412
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
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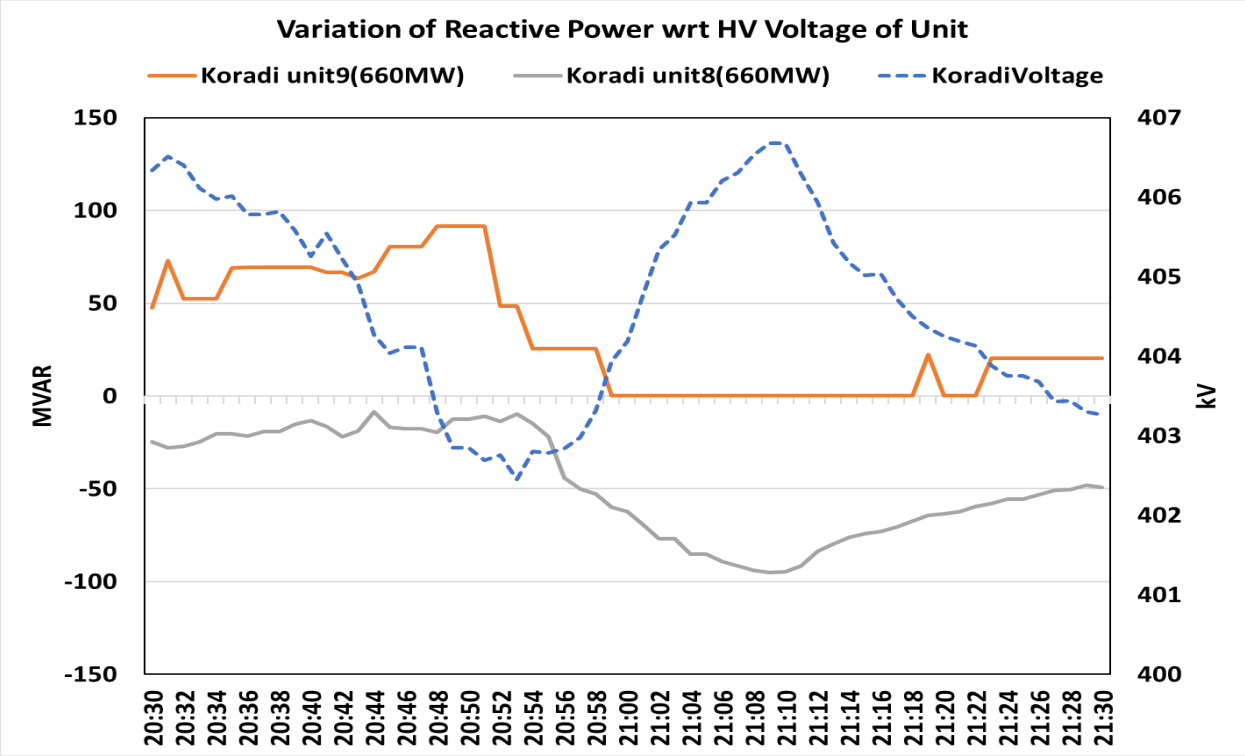
Variation of Reactive Power wrt HV Voltage of Unit
Koradi unit9(660MW)
Koradi unit8(660MW)
KoradiVoltage
MVAR
kV
150
100
50
0
-50
-100
-150
407
406
405
404
403
402
401
400
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
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20:50
20:52
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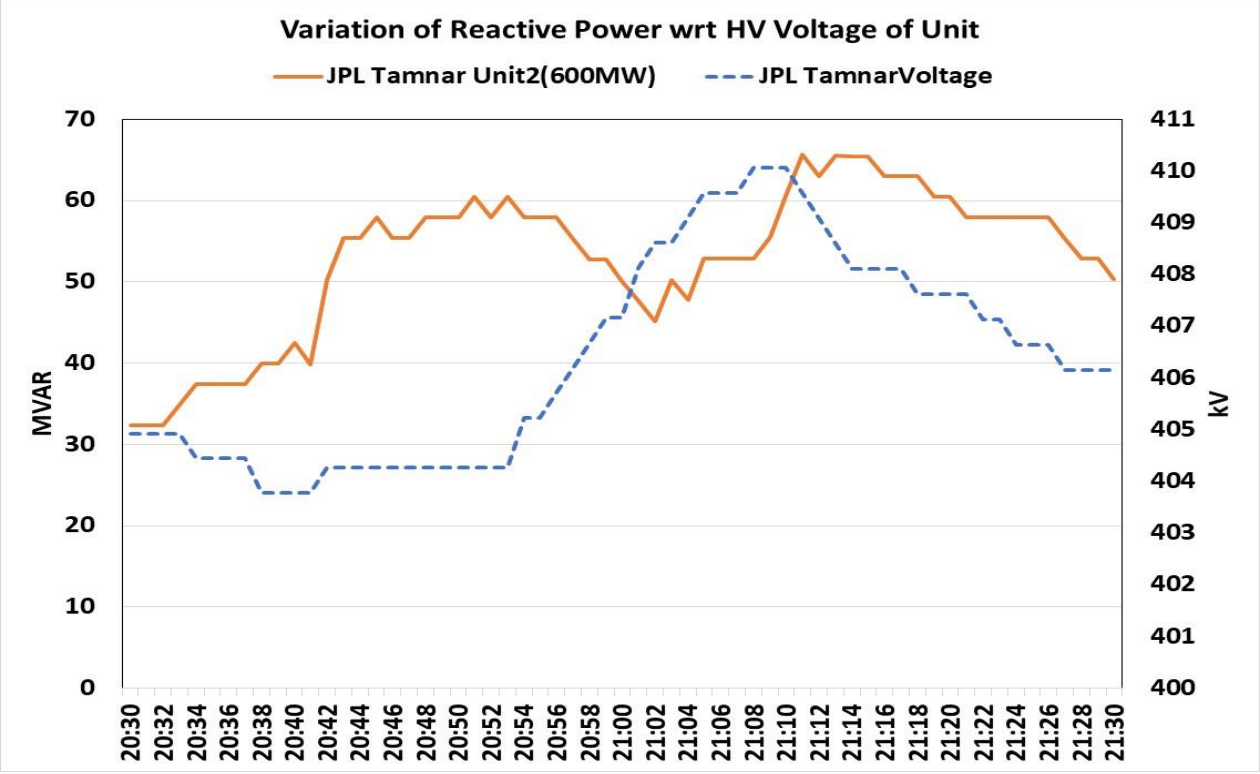
Variation of Reactive Power wrt HV Voltage of Unit
JPL Tamnar Unit2(600MW)
JPL TamnarVoltage
MVAR
kV
70
60
50
40
30
20
10
0
411
410
409
408
407
406
405
404
403
402
401
400
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
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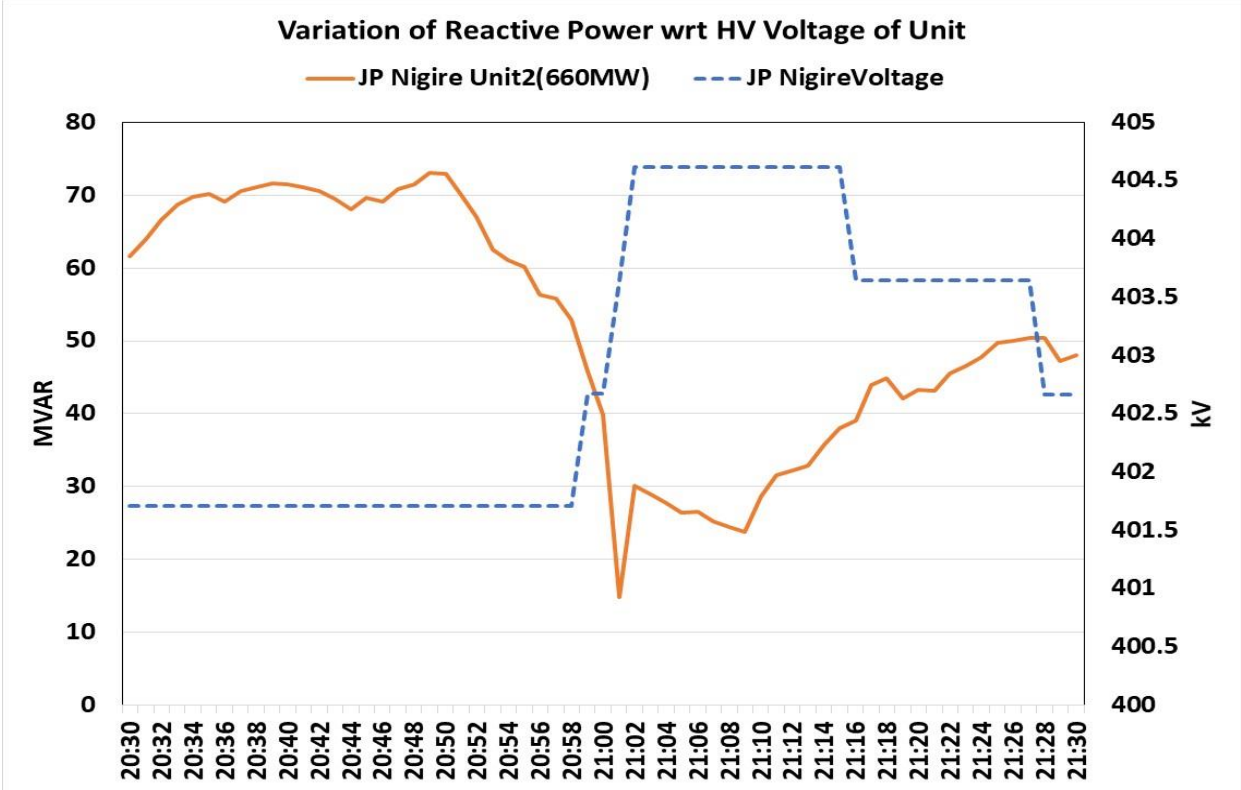
Variation of Reactive Power wrt HV Voltage of Unit
JP Nigire Unit2(660MW)
JP NigireVoltage
MVAR
kV
80
70
60
50
40
30
20
10
0
405
404.5
404
403.5
403
402.5
402
401.5
401
400.5
400
20:30
20:32
20:34
20:36
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20:42
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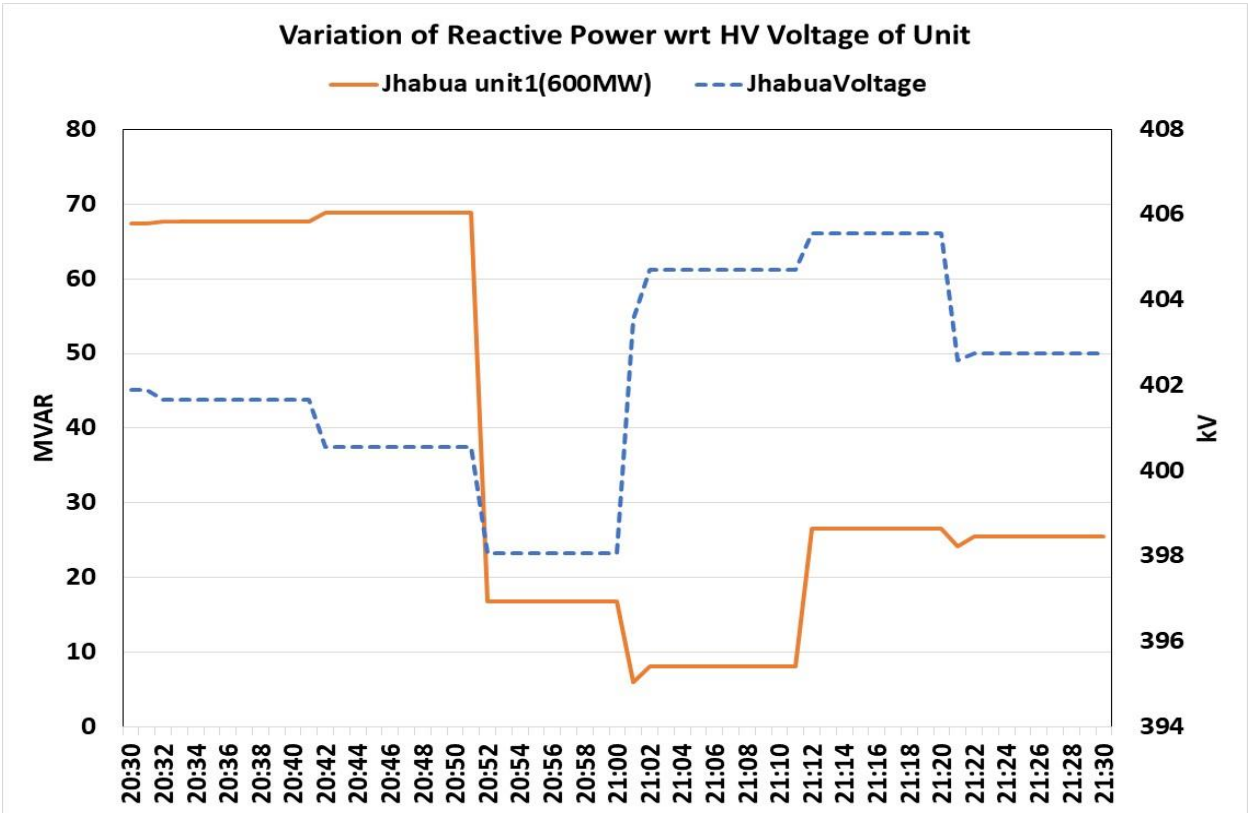
Variation of Reactive Power wrt HV Voltage of Unit
Jhabua unit1(600MW)
JhabuaVoltage
MVAR
kV
80
70
60
50
40
30
20
10
0
408
406
404
402
400
398
396
394
20:30
20:32
20:34
20:36
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20:40
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20:44
20:46
20:48
20:50
20:52
20:54
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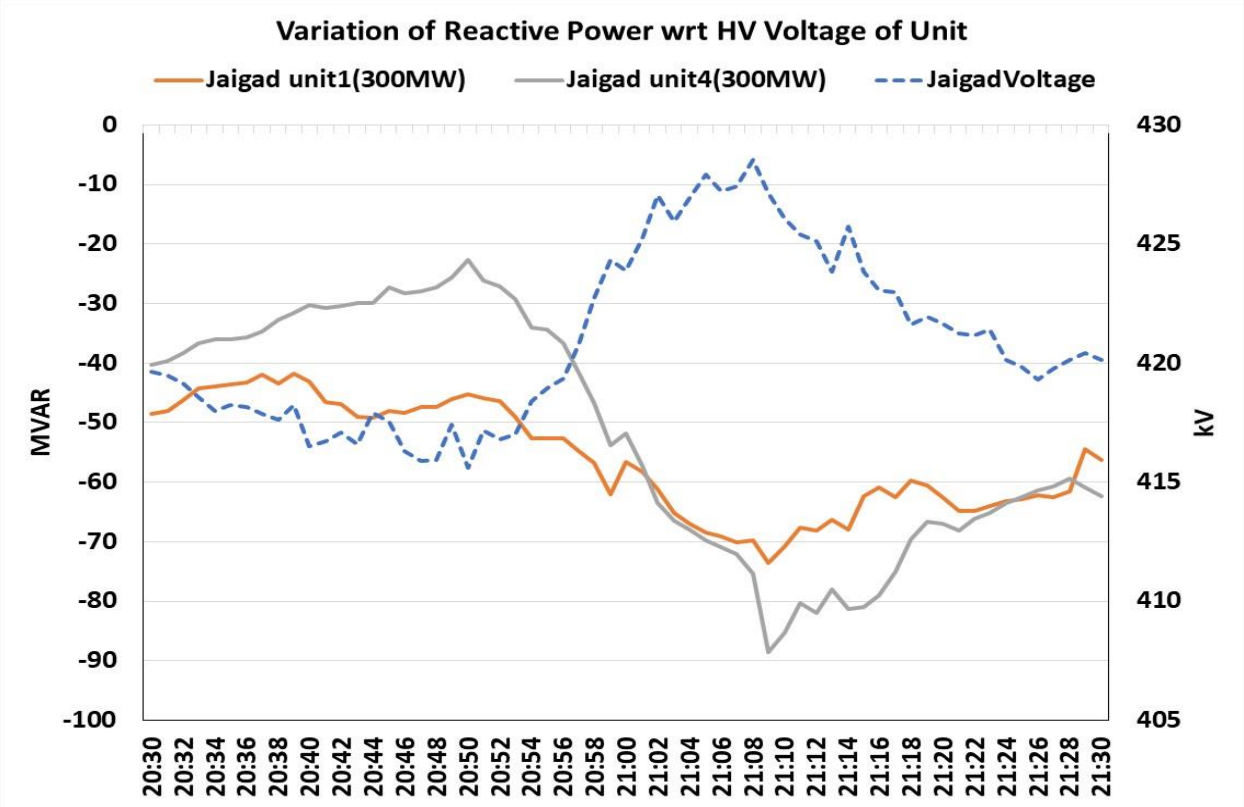
Variation of Reactive Power wrt HV Voltage of Unit
Jaigad unit1(300MW)
Jaigad unit4(300MW)
JaigadVoltage
MVAR
kV
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
430
425
420
415
410
405
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
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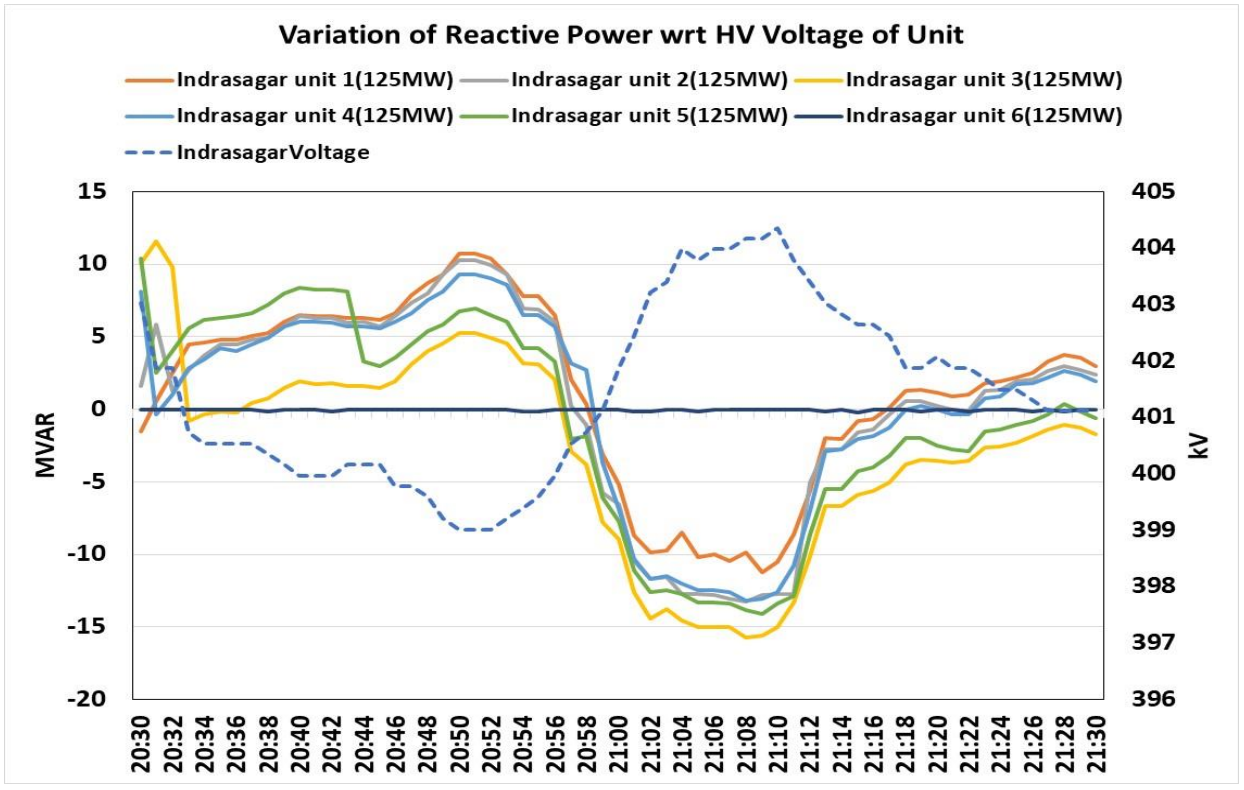
Variation of Reactive Power wrt HV Voltage of Unit
Indrasagar unit 1(125MW)
Indrasagar unit 2(125MW)
Indrasagar unit 3(125MW)
Indrasagar unit 4(125MW)
Indrasagar unit 5(125MW)
Indrasagar unit 6(125MW)
IndrasagarVoltage
MVAR
kV
15
10
5
0
-5
-10
-15
-20
405
404
403
402
401
400
399
398
397
396
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
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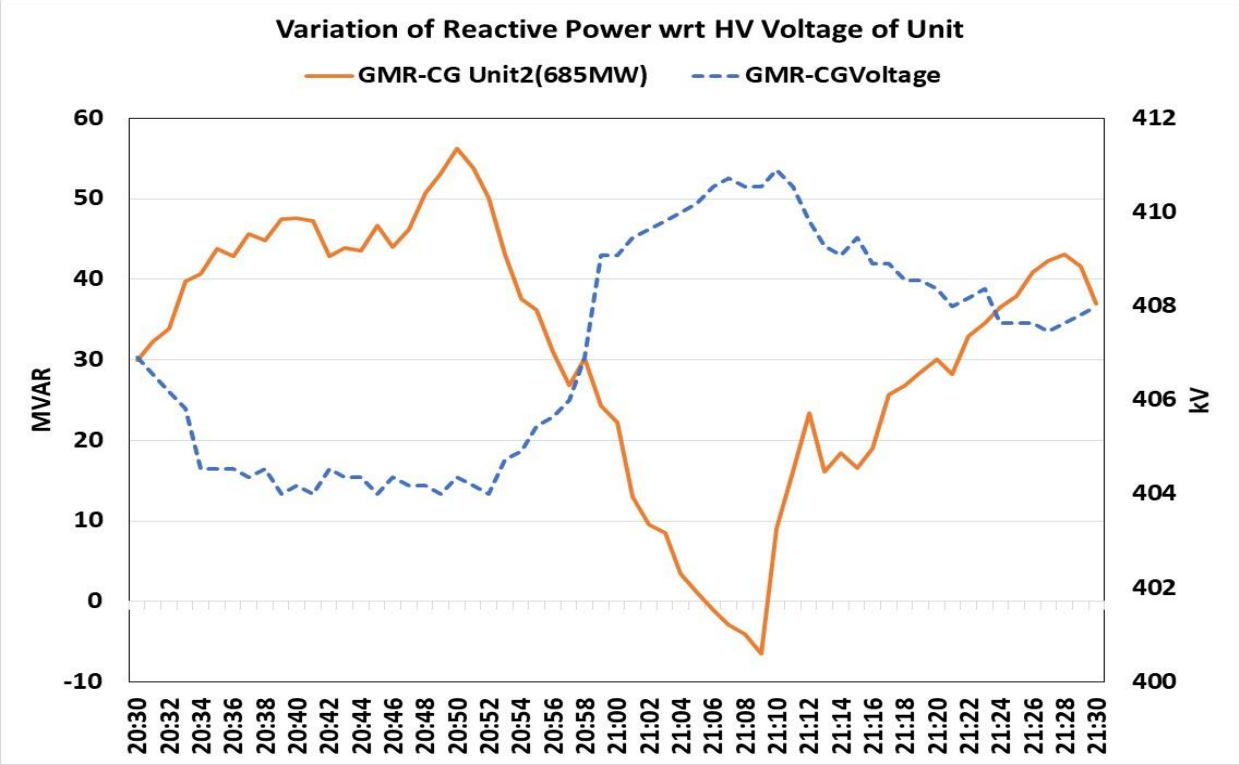
Variation of Reactive Power wrt HV Voltage of Unit
GMR-CG Unit2(685MW)
GMR-CGVoltage
MVAR
kV
60
50
40
30
20
10
0
-10
412
410
408
406
404
402
400
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
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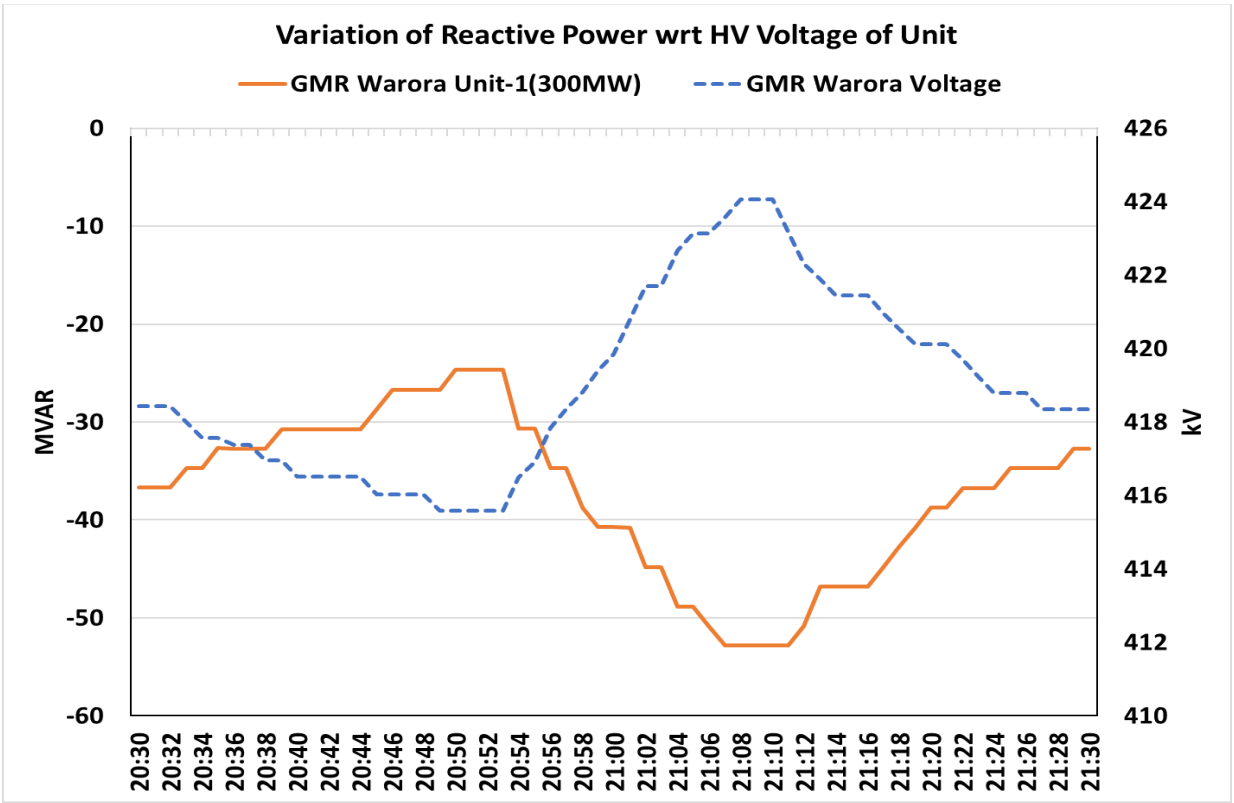
Variation of Reactive Power wrt HV Voltage of Unit
GMR Warora Unit-1(300MW)
GMR Warora Voltage
MVAR
kV
0
-10
-20
-30
-40
-50
-60
426
424
422
420
418
416
414
412
410
20:30
20:32
20:34
20:36
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20:40
20:42
20:44
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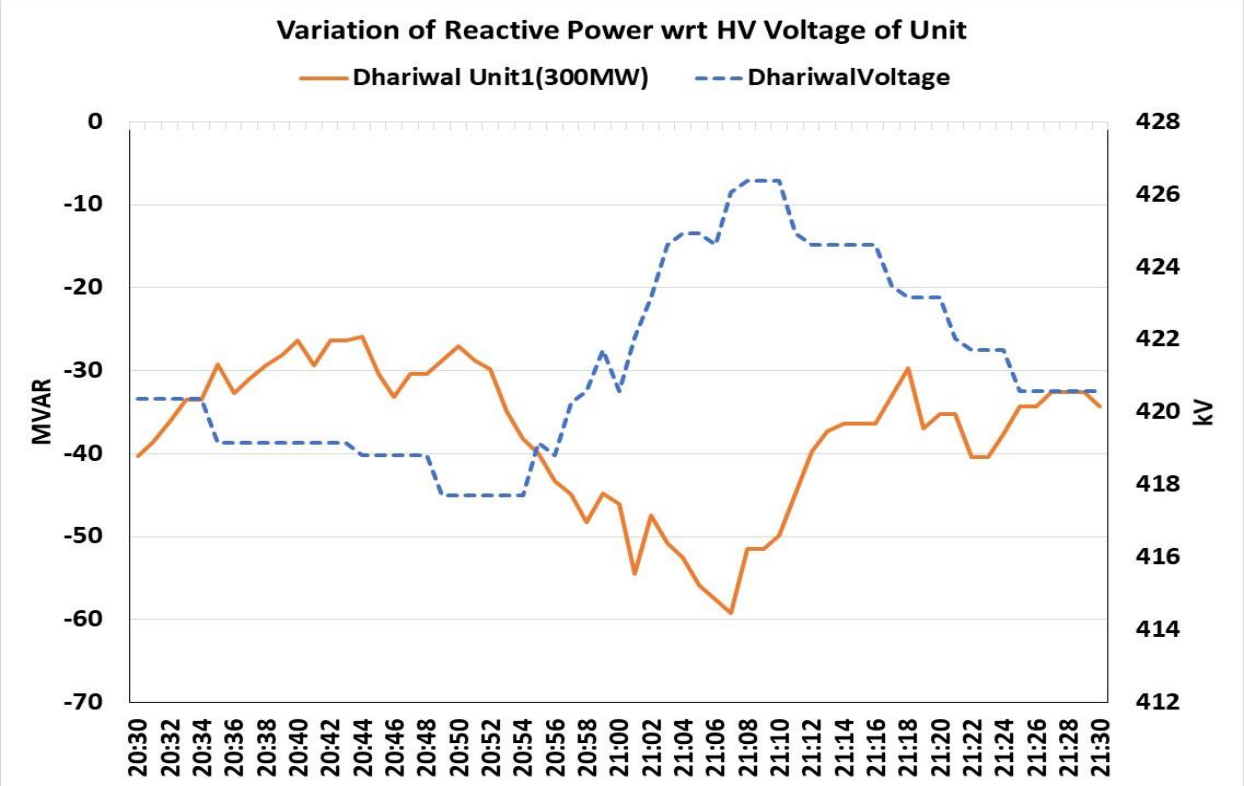
Variation of Reactive Power wrt HV Voltage of Unit
Dhariwal Unit1(300MW)
DhariwalVoltage
MVAR
kV
0
-10
-20
-30
-40
-50
-60
-70
428
426
424
422
420
418
416
414
412
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
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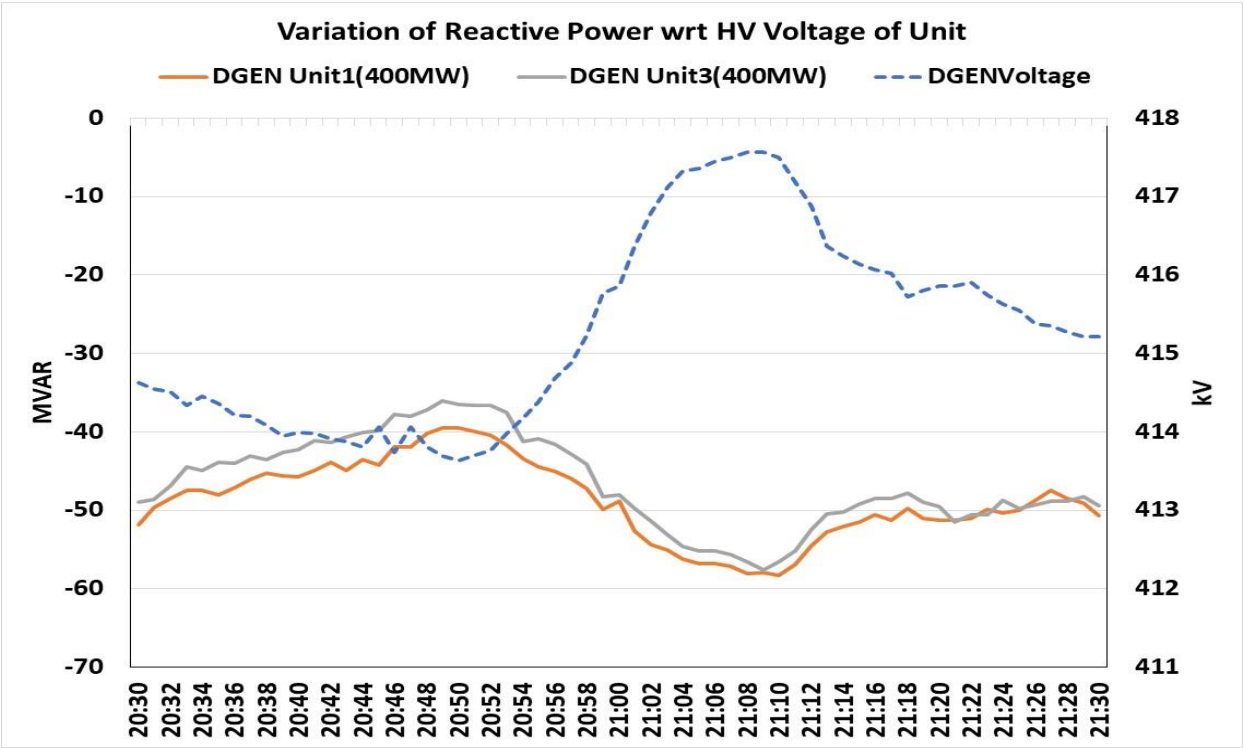
Variation of Reactive Power wrt HV Voltage of Unit
DGEN Unit1(400MW)
DGEN Unit3(400MW)
DGENVoltage
MVAR
kV
0
-10
-20
-30
-40
-50
-60
-70
418
417
416
415
414
413
412
411
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
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20:56
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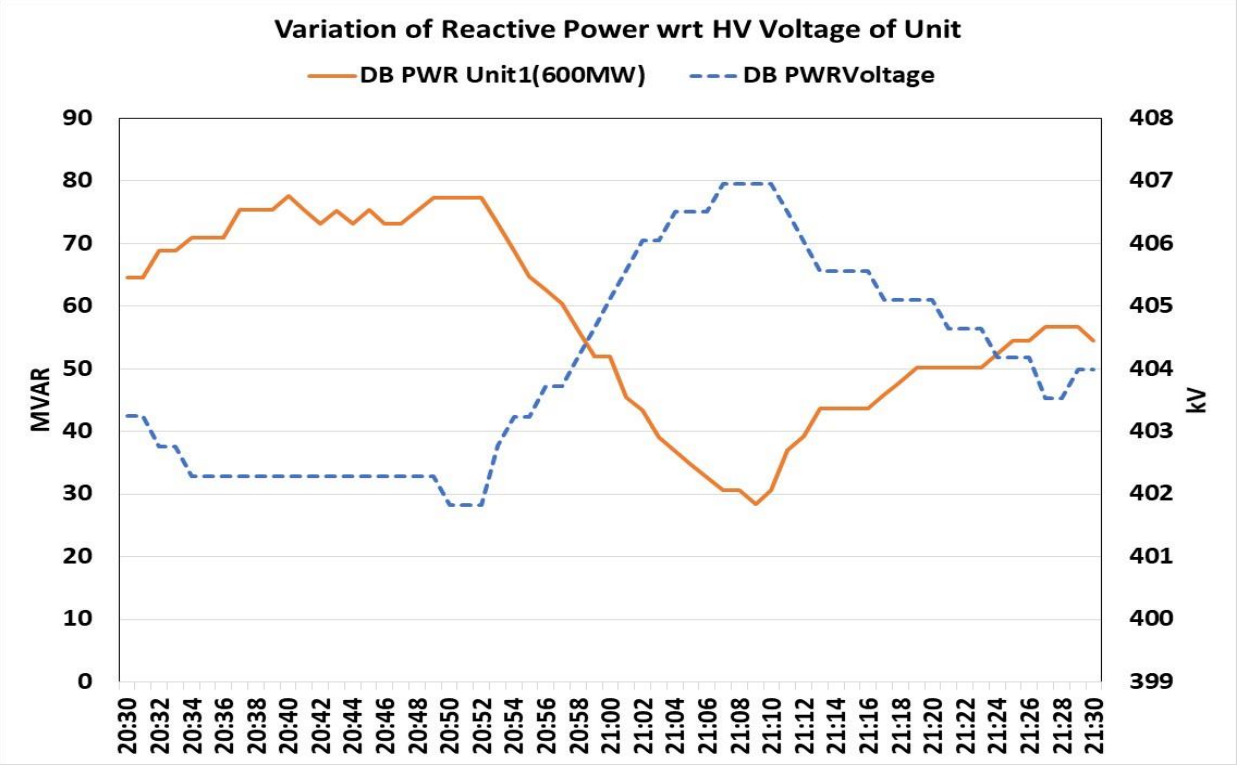
Variation of Reactive Power wrt HV Voltage of Unit
DB PWR Unit1(600MW)
DB PWRVoltage
MVAR
kV
90
80
70
60
50
40
30
20
10
0
408
407
406
405
404
403
402
401
400
399
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
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20:48
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20:52
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20:56
20:58
21:00
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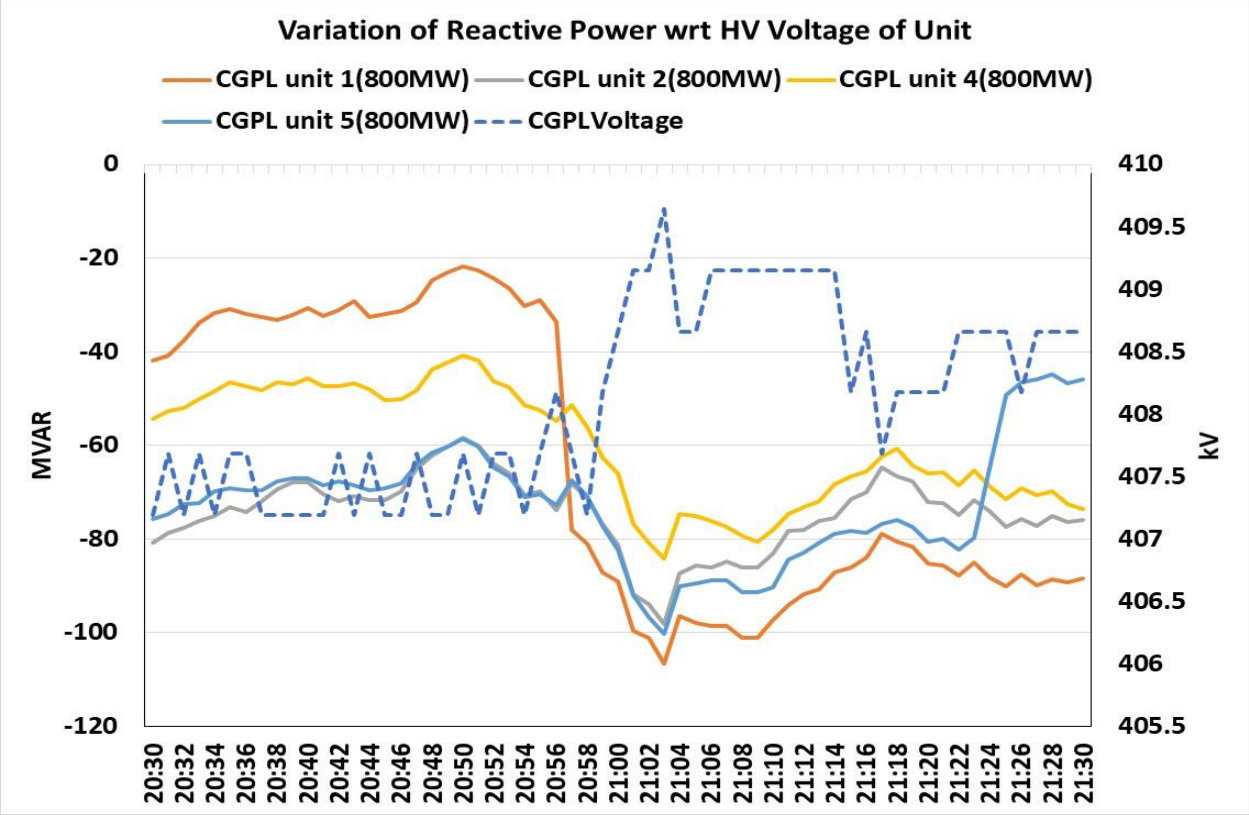
Variation of Reactive Power wrt HV Voltage of Unit
CGPL unit 1(800MW)
CGPL unit 2(800MW)
CGPL unit 4(800MW)
CGPL unit 5(800MW)
CGPLVoltage
MVAR
kV
0
-20
-40
-60
-80
-100
-120
410
409.5
409
408.5
408
407.5
407
406.5
406
405.5
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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21:22
21:24
21:26
21:28
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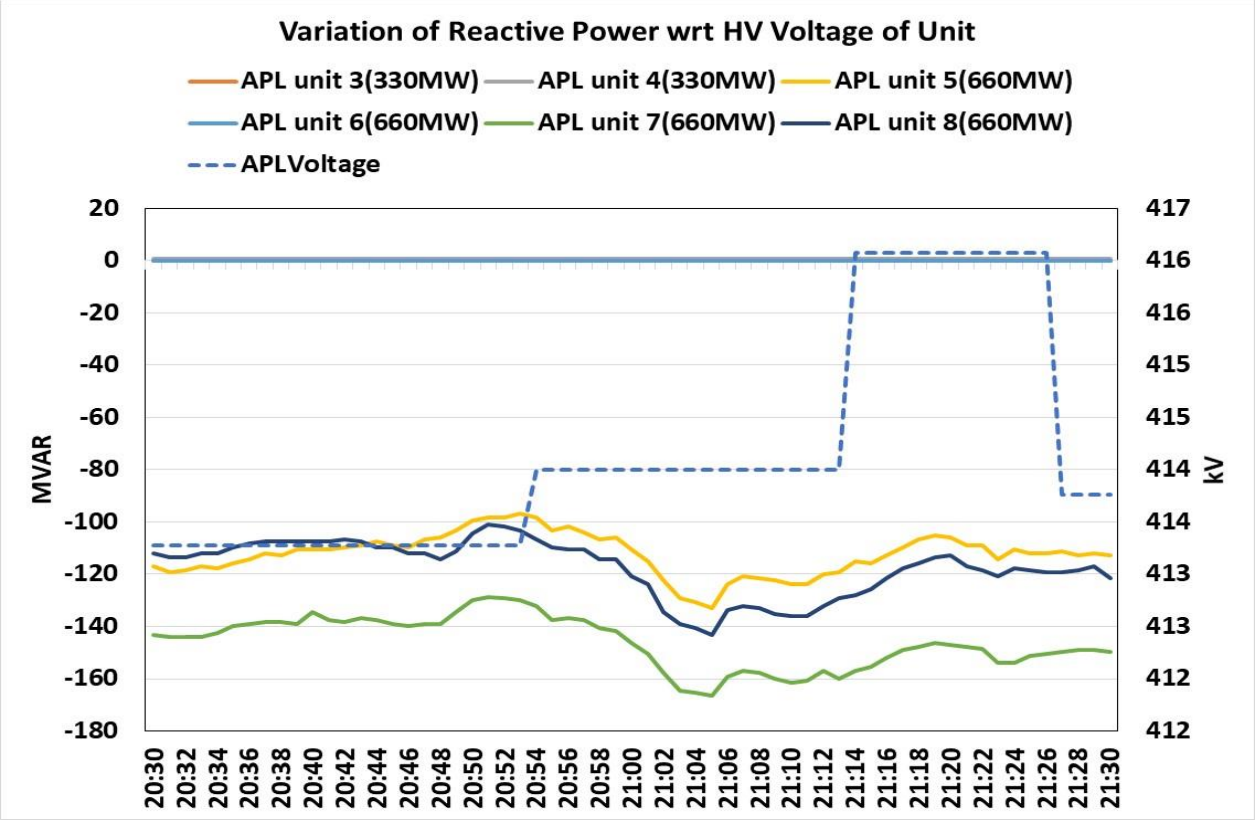
Variation of Reactive Power wrt HV Voltage of Unit
APL unit 3(330MW)
APL unit 4(330MW)
APL unit 5(660MW)
APL unit 6(660MW)
APL unit 7(660MW)
APL unit 8(660MW)
APLVoltage
MVAR
kV
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
417
416
416
415
415
414
414
413
413
412
412
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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21:18
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21:22
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21:26
21:28
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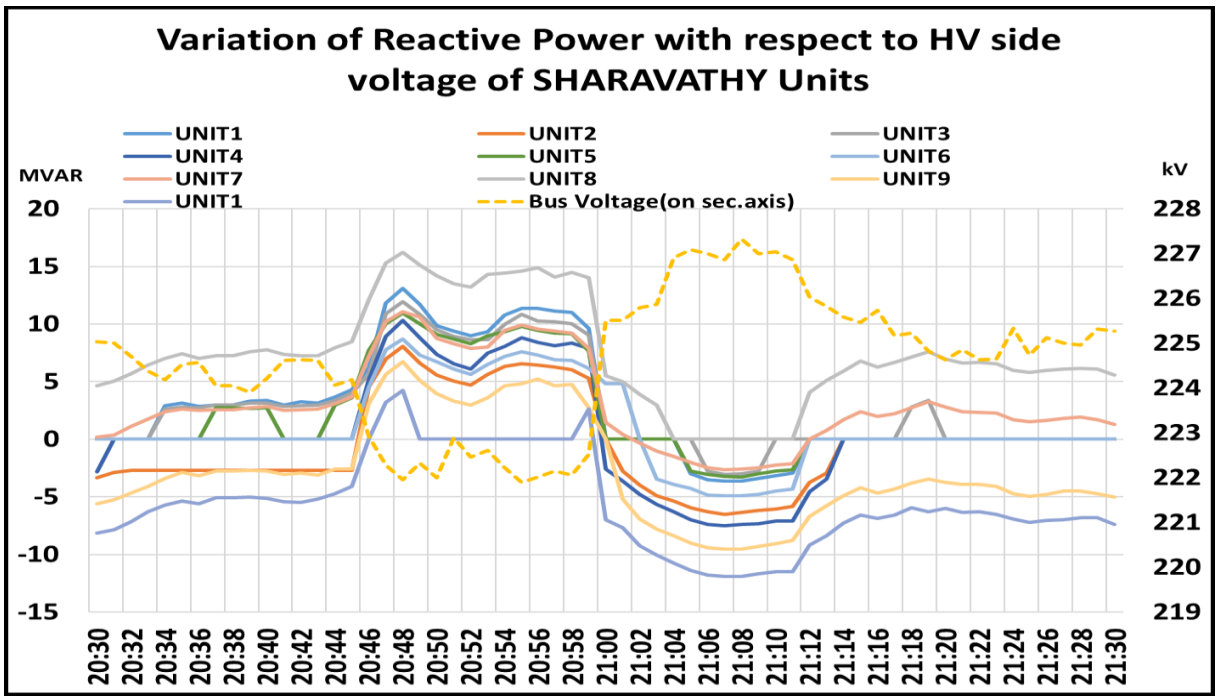
Variation of Reactive Power with respect to HV side voltage of SHARAVATHY Units
UNIT1
UNIT2
UNIT3
UNIT4
UNIT5
UNIT6
UNIT7
UNIT8
UNIT9
UNIT1
Bus Voltage(on sec.axis)
MVAR
kV
20
15
10
5
0
-5
-10
-15
228
227
226
225
224
223
222
221
220
219
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
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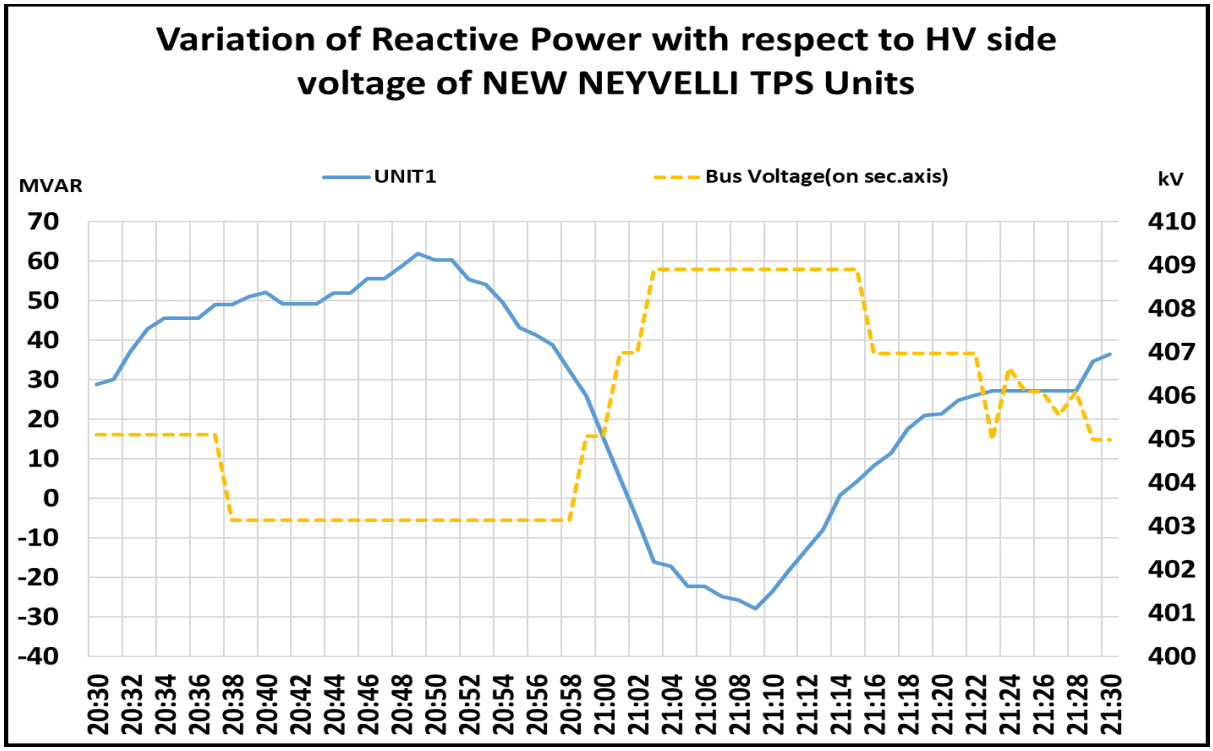
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of NEW NEYVELLI TPS Units
UNIT1
Bus Voltage(on sec.axis)
MVAR
kV
70
60
50
40
30
20
10
0
-10
-20
-30
-40
410
409
408
407
406
405
404
403
402
401
400
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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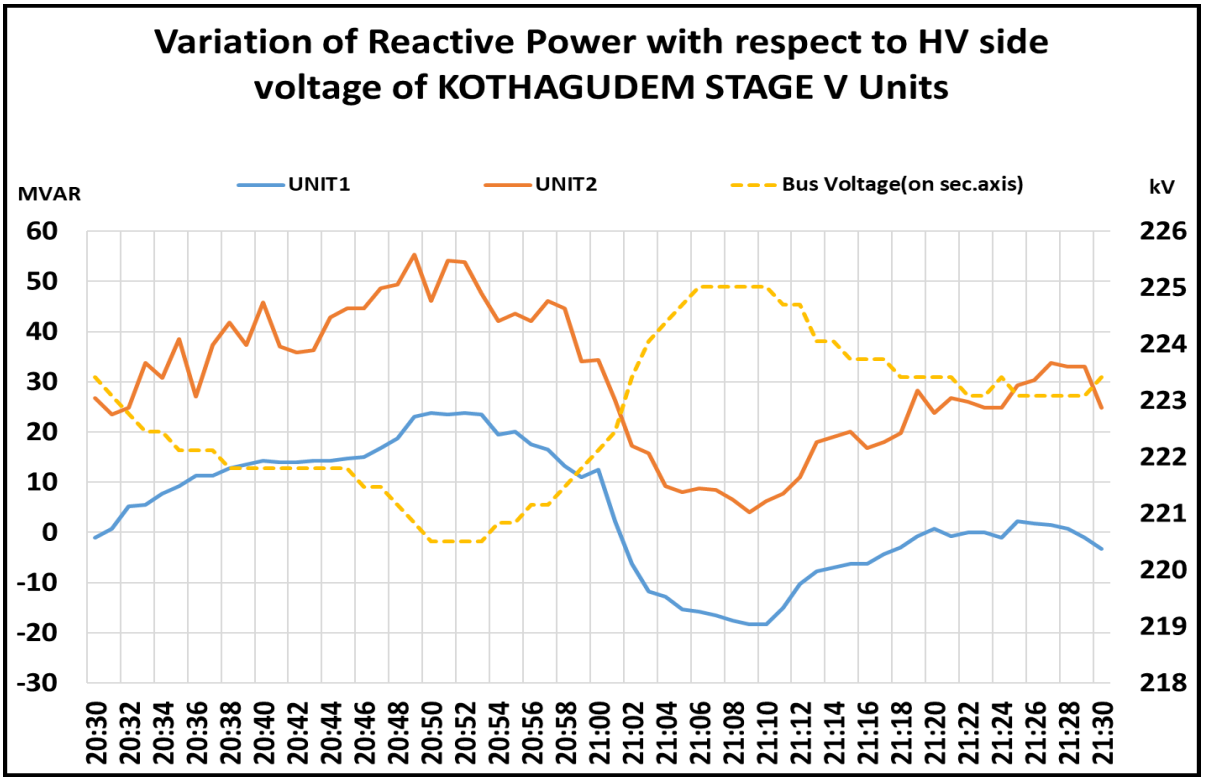
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of KOTHAGUDEM STAGE V Units
MVAR
UNIT1
UNIT2
Bus Voltage(on sec.axis)
kV
60
50
40
30
20
10
0
-10
-20
-30
226
225
224
223
222
221
220
219
218
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
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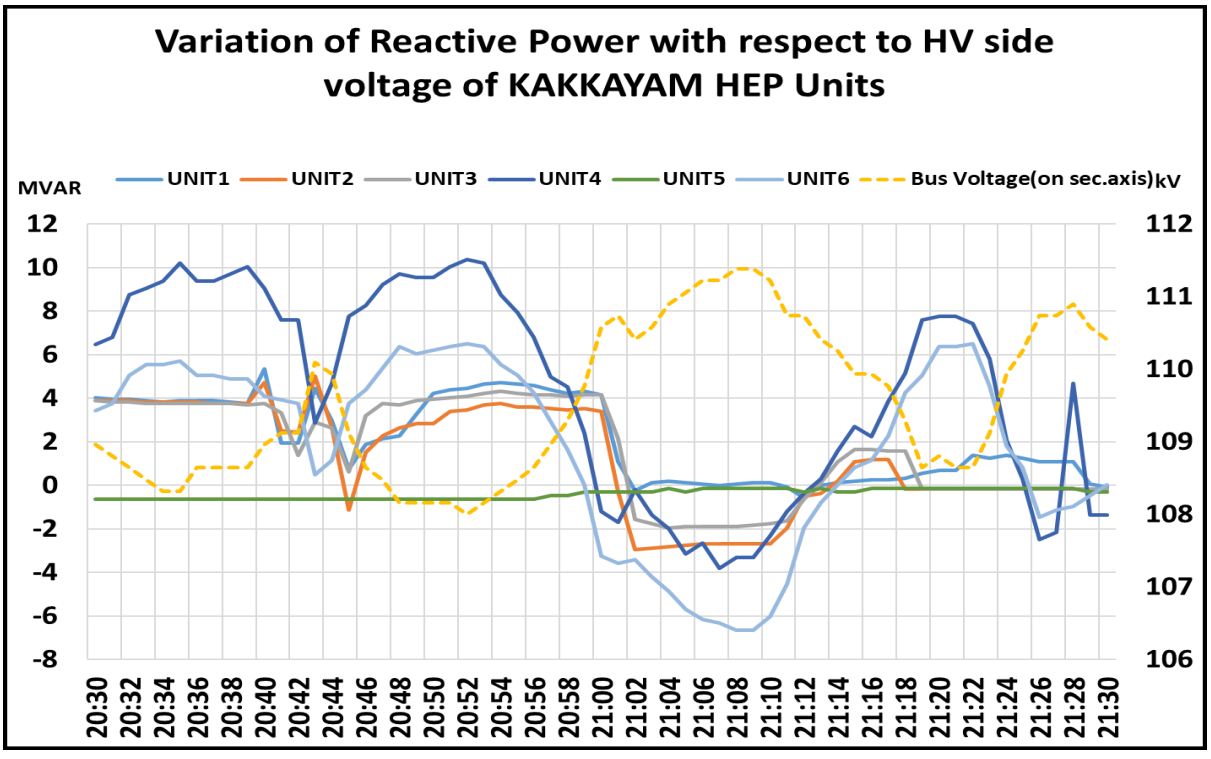
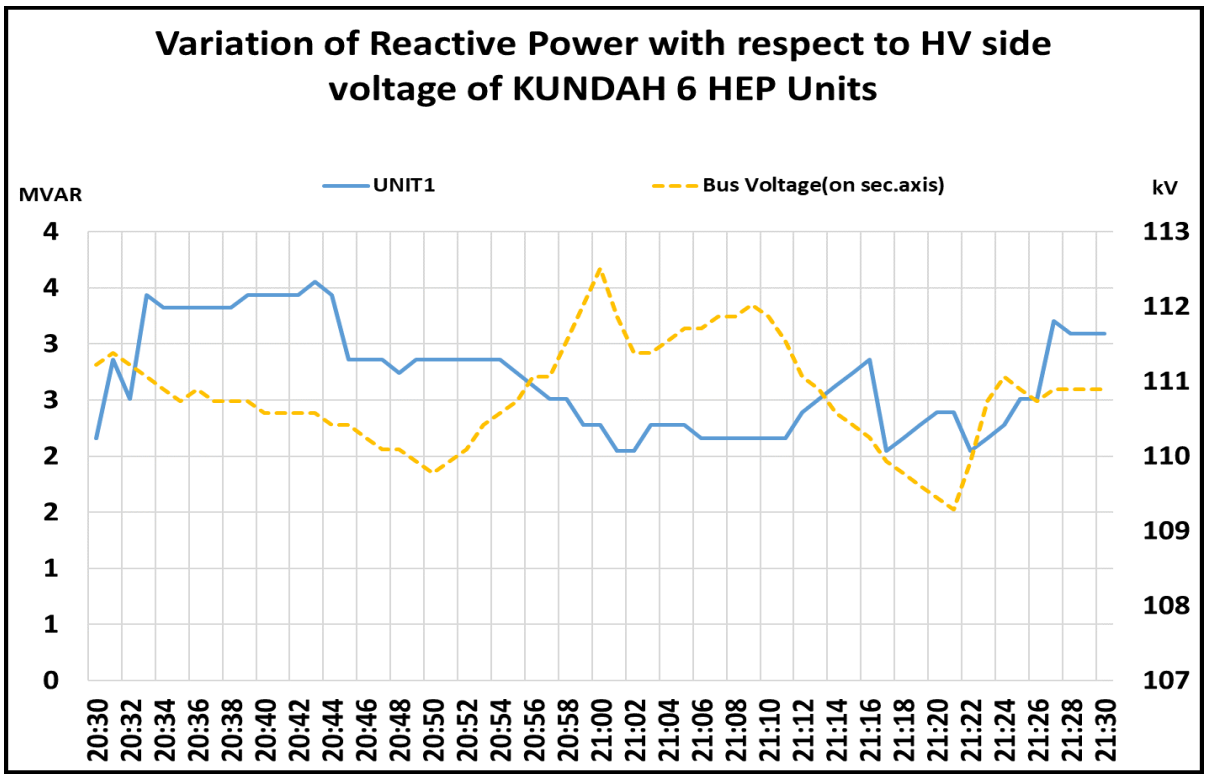
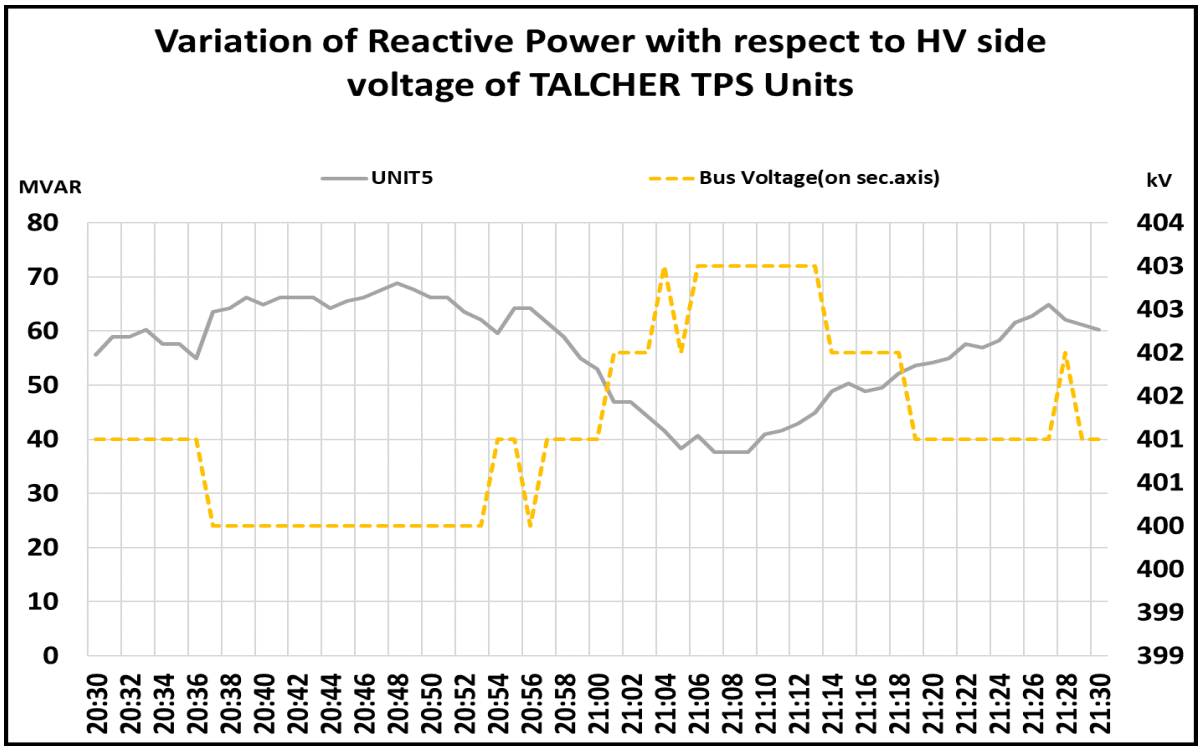
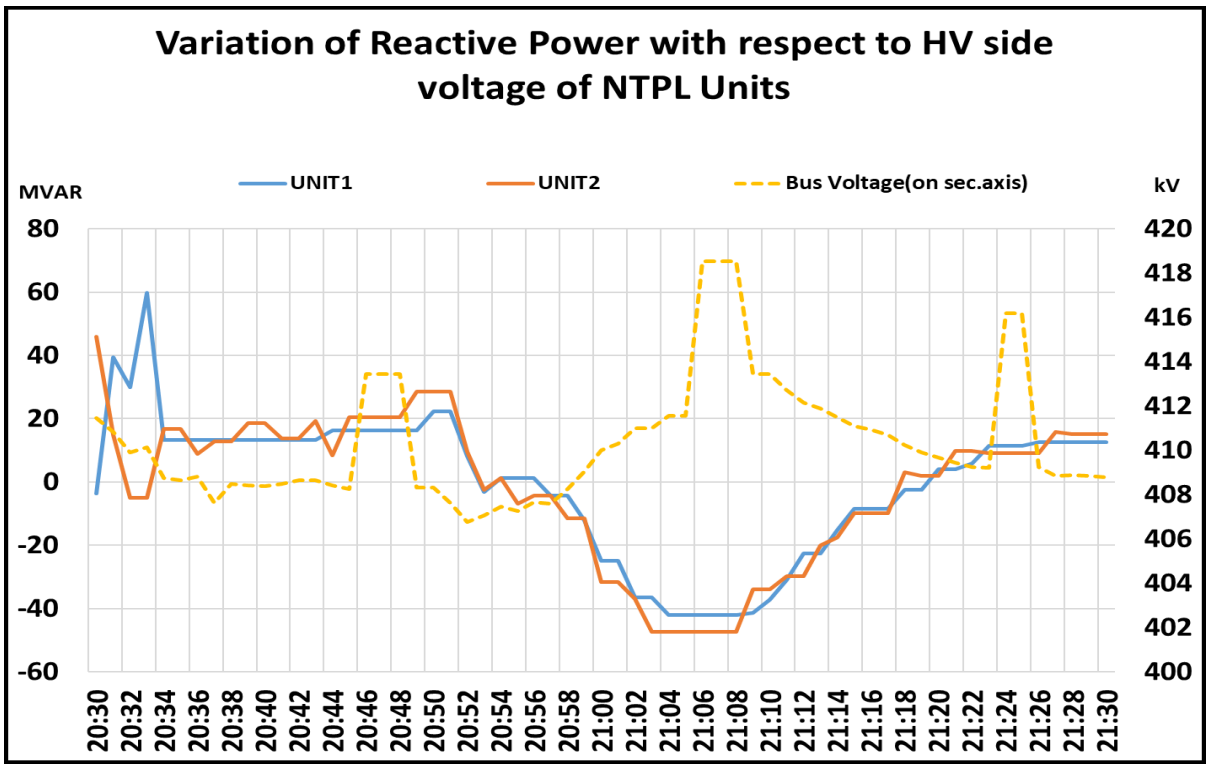
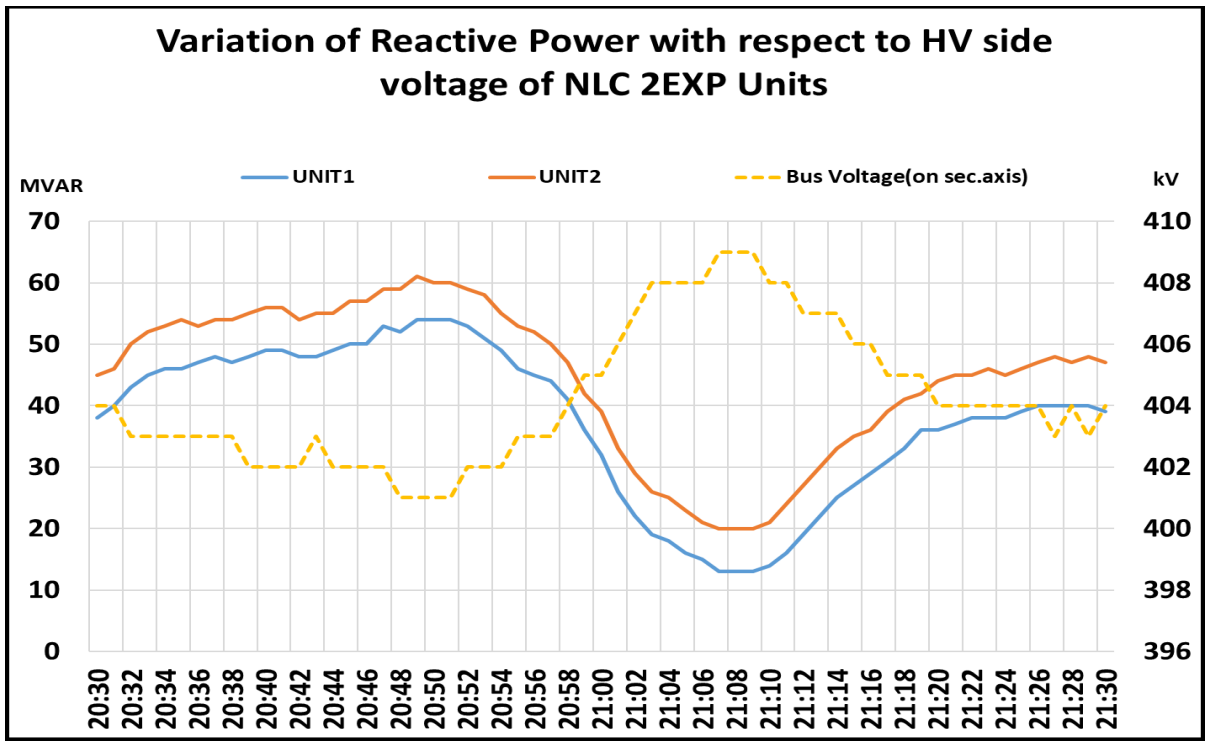
21:18
21:20
21:22
21:24
21:26
21:28
21:30

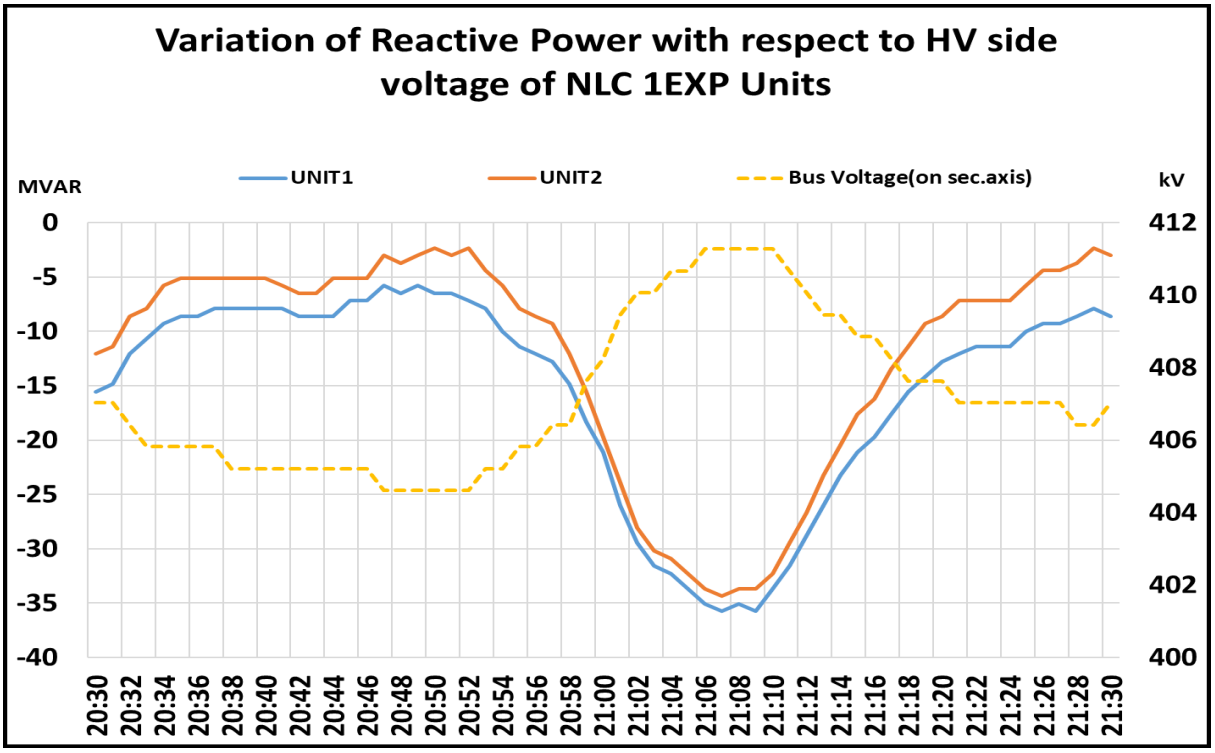

Variation of Reactive Power with respect to HV side voltage of KAKKAYAM HEP Units
MVAR
UNIT1
UNIT2
UNIT3
UNIT4
UNIT5
UNIT6
Bus Voltage(on sec.axis)
kV
12
10
8
6
4
2
0
-2
-4
-6
-8
112
111
110
109
108
107
106
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

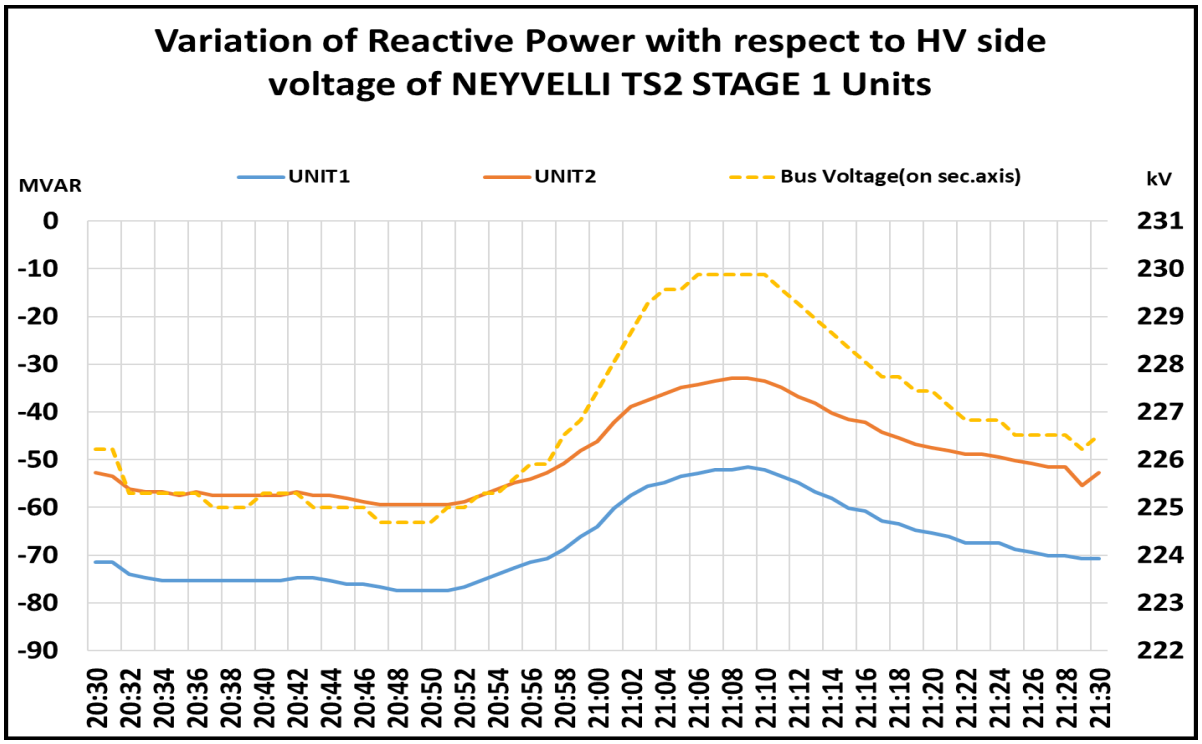

Variation of Reactive Power with respect to HV side voltage of KUNDAH 6 HEP Units
MVAR
UNIT1
Bus Voltage(on sec.axis)
kV
4
4
3
3
2
2
1
1
0
113
112
111
110
109
108
107
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

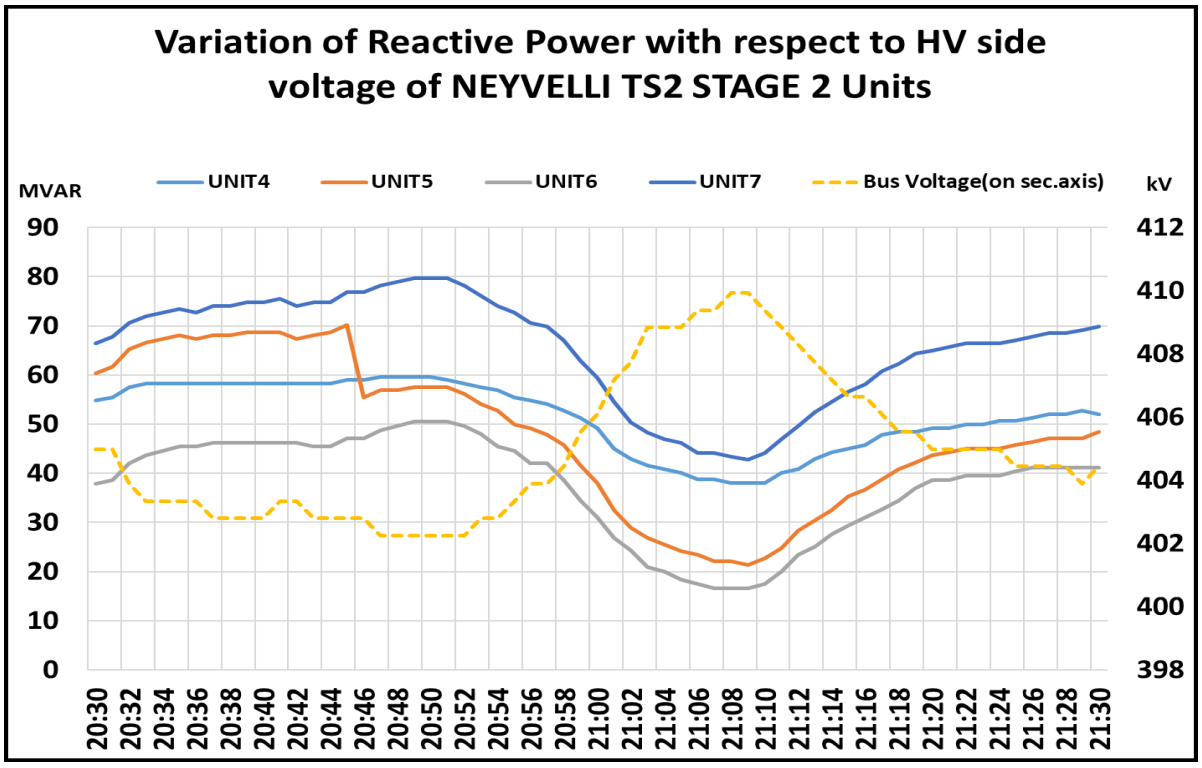

Variation of Reactive Power with respect to HV side voltage of TALCHER TPS Units
MVAR
UNIT5
Bus Voltage(on sec.axis)
kV
80
70
60
50
40
30
20
10
0
404
403
403
402
402
401
401
400
400
399
399
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

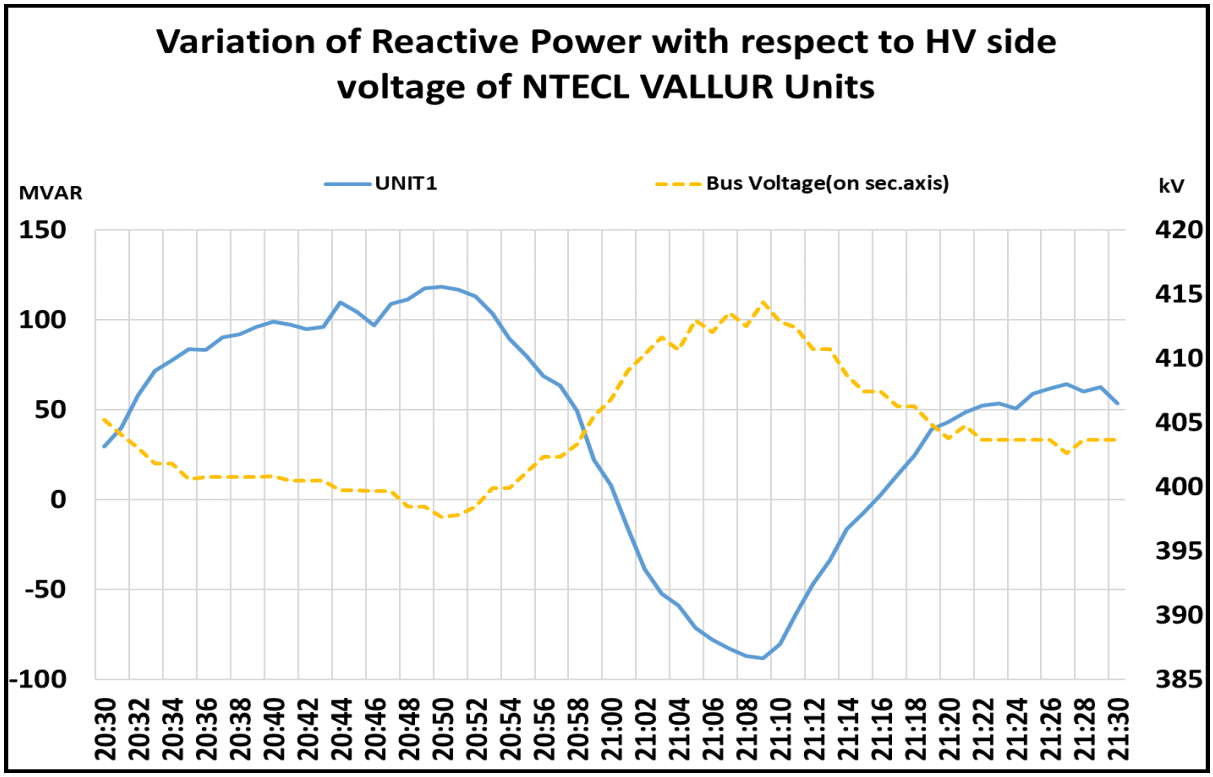

Variation of Reactive Power with respect to HV side voltage of NTPL Units
MVAR
UNIT1
UNIT2
Bus Voltage(on sec.axis)
kV
80
60
40
20
0
-20
-40
-60
420
418
416
414
412
410
408
406
404
402
400
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

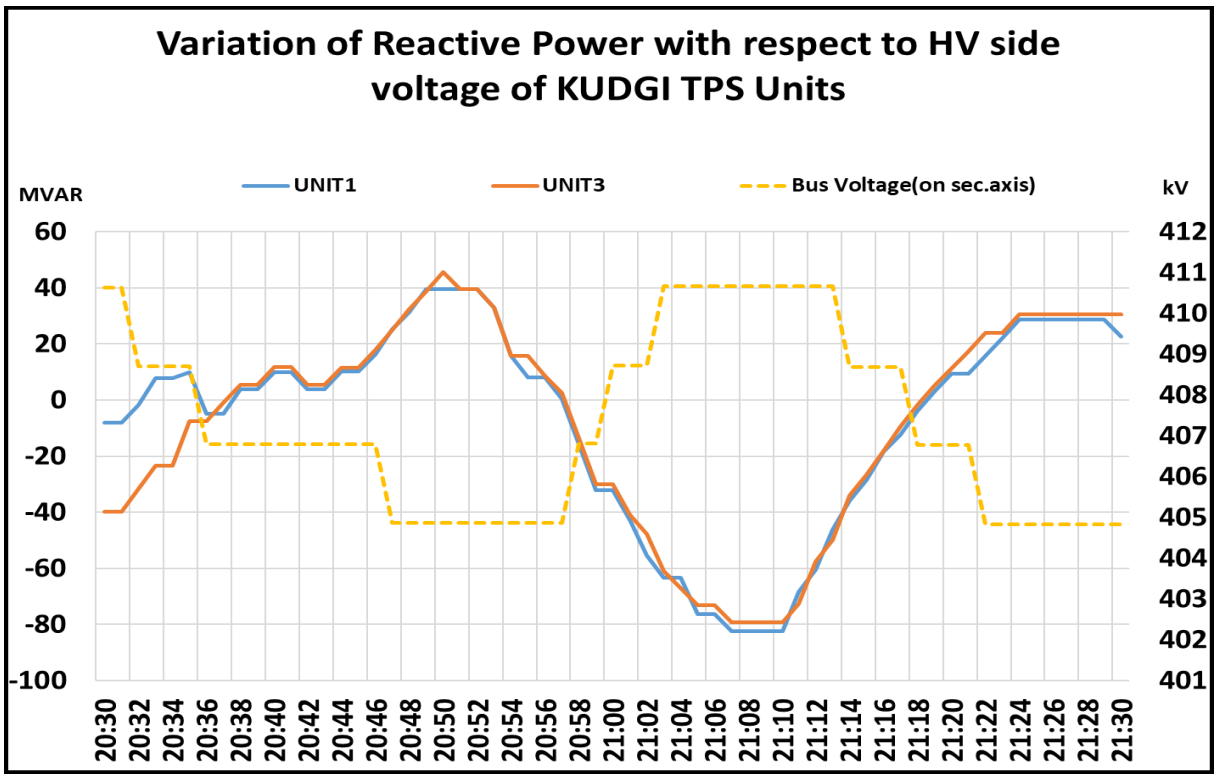

Variation of Reactive Power with respect to HV side voltage of NLC 2EXP Units
MVAR
UNIT1
UNIT2
Bus Voltage(on sec.axis)
kV
70
60
50
40
30
20
10
0
410
408
406
404
402
400
398
396
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

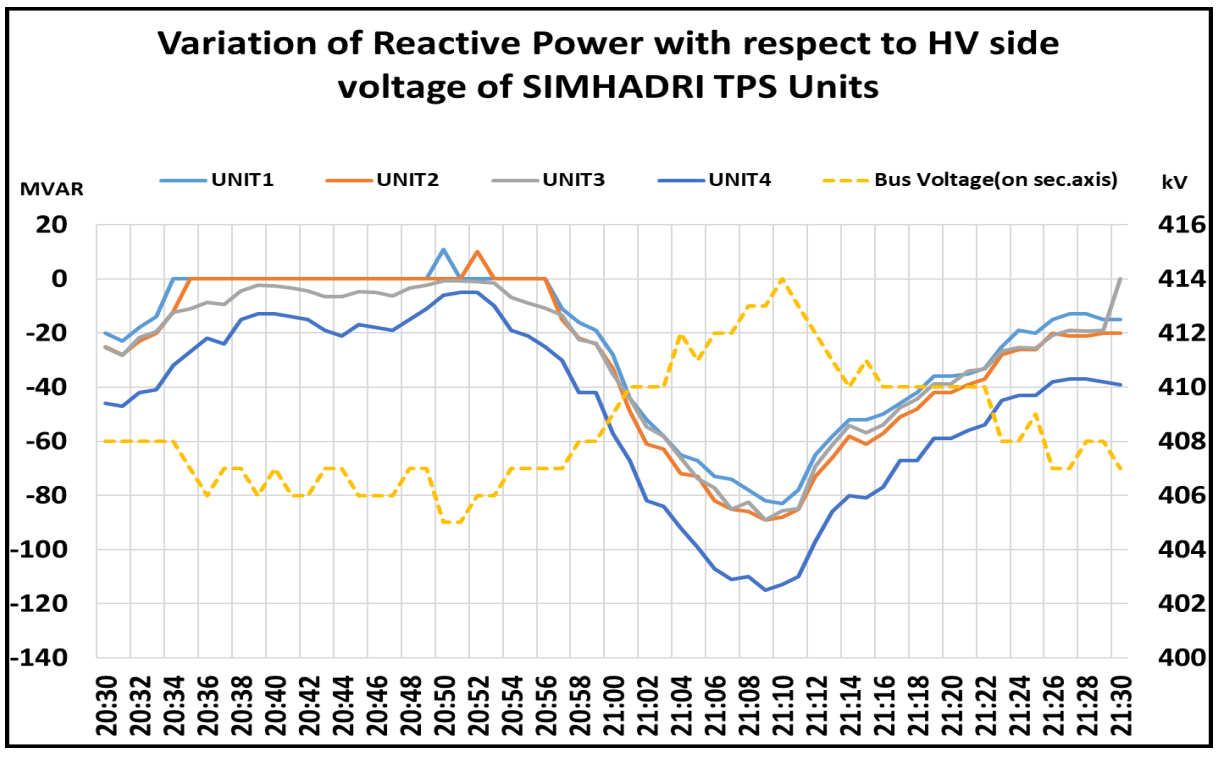

Variation of Reactive Power with respect to HV side voltage of NLC 1EXP Units
MVAR
UNIT1
UNIT2
Bus Voltage(on sec.axis)
kV
0
-5
-10
-15
-20
-25
-30
-35
-40
412
410
408
406
404
402
400
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

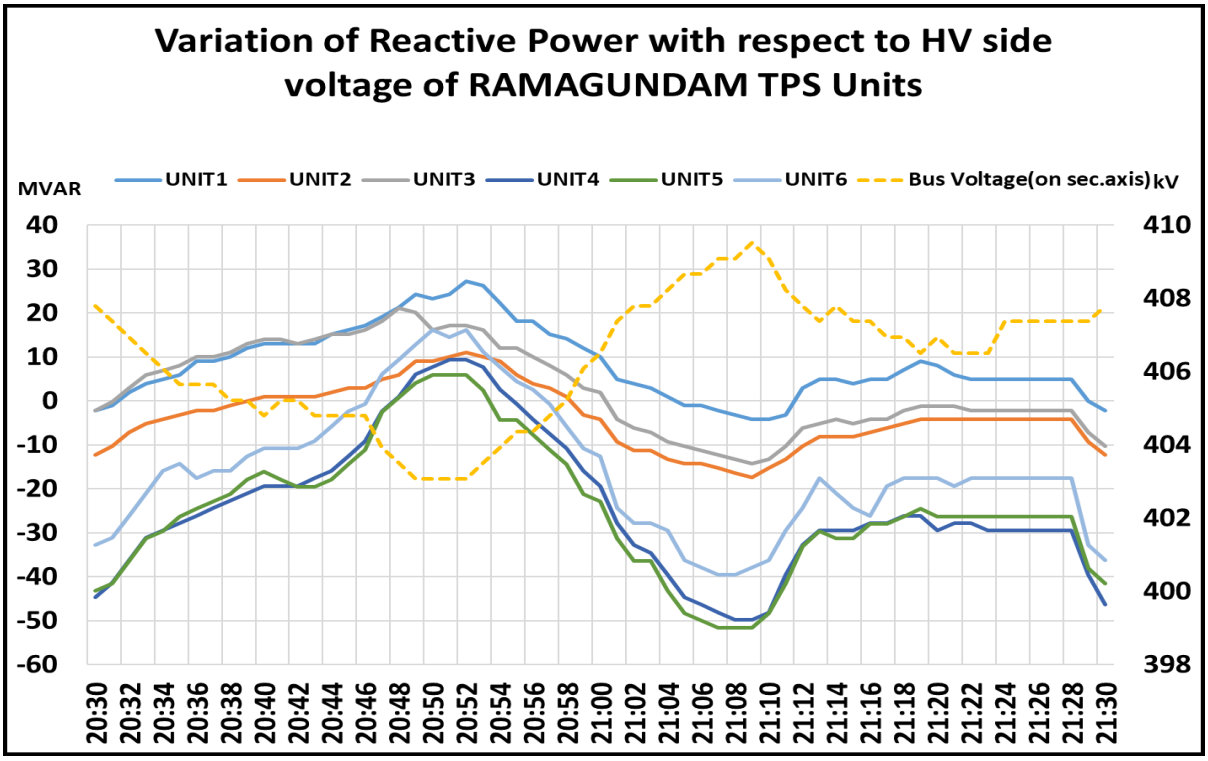

Variation of Reactive Power with respect to HV side voltage of NEYVELLI TS2 STAGE 1 Units
MVAR
UNIT1
UNIT2
Bus Voltage(on sec.axis)
kV
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
231
230
229
228
227
226
225
224
223
222
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

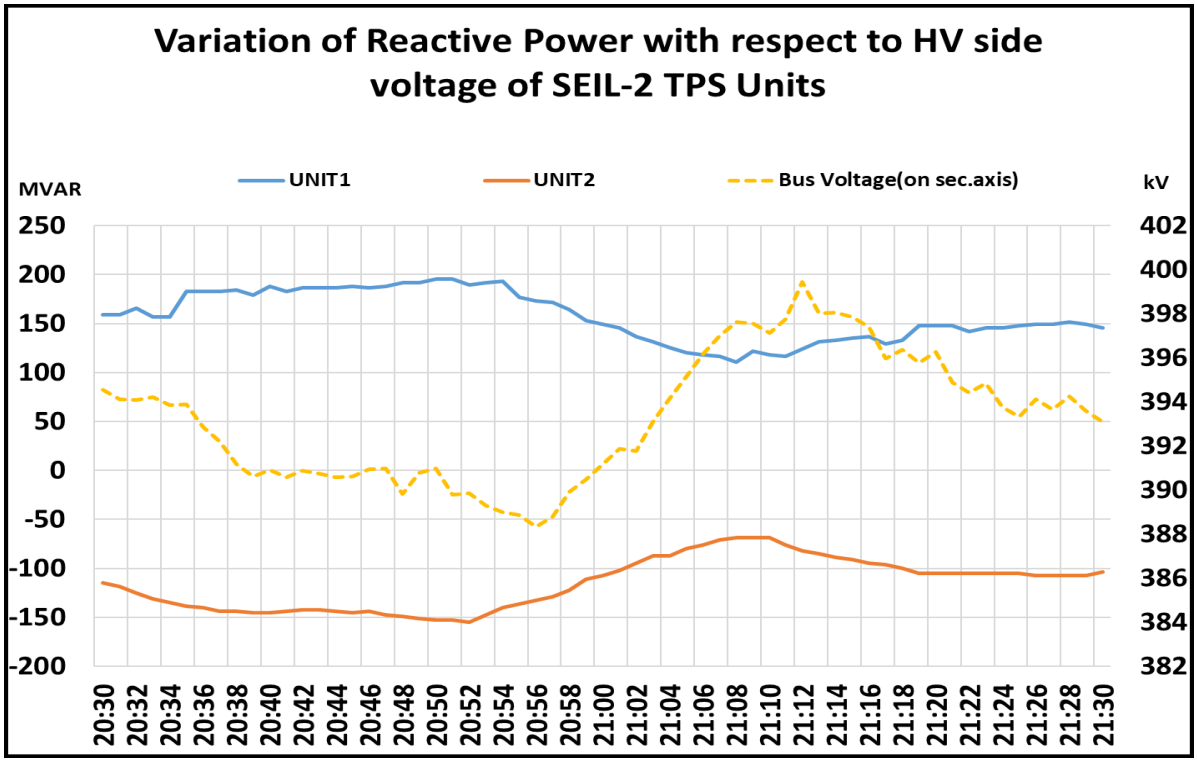

Variation of Reactive Power with respect to HV side voltage of NEYVELLI TS2 STAGE 2 Units
MVAR
UNIT4
UNIT5
UNIT6
UNIT7
Bus Voltage(on sec.axis)
kV
90
80
70
60
50
40
30
20
10
0
412
410
408
406
404
402
400
398
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

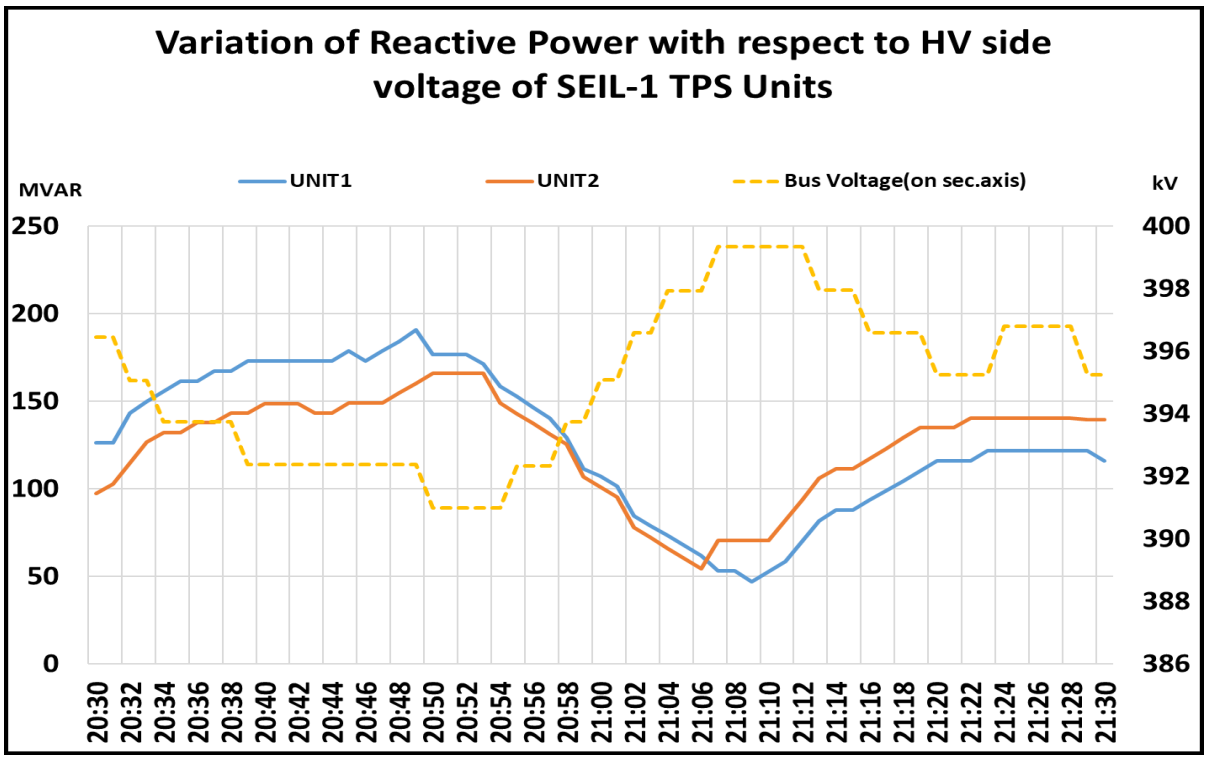

Variation of Reactive Power with respect to HV side voltage of NTECL VALLUR Units
MVAR
UNIT1
Bus Voltage(on sec.axis)
kV
150
100
50
0
-50
-100
420
415
410
405
400
395
390
385
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of KUDGI TPS Units
MVAR
kV
UNIT1
UNIT3
Bus Voltage(on sec.axis)
60
40
20
0
-20
-40
-60
-80
-100
412
411
410
409
408
407
406
405
404
403
402
401
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of SIMHADRI TPS Units
MVAR
kV
UNIT1
UNIT2
UNIT3
UNIT4
Bus Voltage(on sec.axis)
20
0
-20
-40
-60
-80
-100
-120
-140
416
414
412
410
408
406
404
402
400
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of RAMAGUNDAM TPS Units
MVAR
UNIT1
UNIT2
UNIT3
UNIT4
UNIT5
UNIT6
Bus Voltage(on sec.axis)
kV
40
30
20
10
0
-10
-20
-30
-40
-50
-60
410
408
406
404
402
400
398
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of SEIL-2 TPS Units
MVAR
UNIT1
UNIT2
Bus Voltage(on sec.axis)
kV
250
200
150
100
50
0
-50
-100
-150
-200
402
400
398
396
394
392
390
388
386
384
382
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of SEIL-1 TPS Units
MVAR
UNIT1
UNIT2
Bus Voltage(on sec.axis)
kV
250
200
150
100
50
0
400
398
396
394
392
390
388
386
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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21:12
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21:24
21:26
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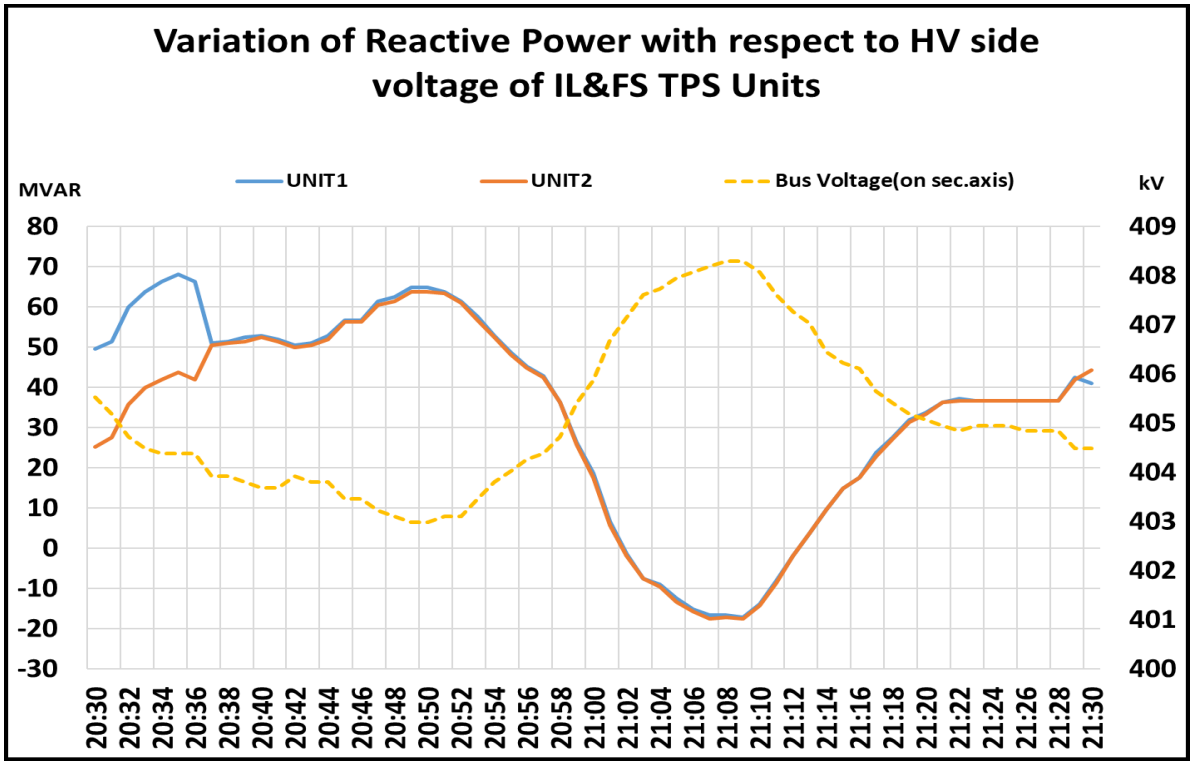
Variation of Reactive Power with respect to HV side voltage of IL&FS TPS Units
MVAR
UNIT1
UNIT2
Bus Voltage(on sec.axis)
kV
80
70
60
50
40
30
20
10
0
-10
-20
-30
409
408
407
406
405
404
403
402
401
400
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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21:18
21:20
21:22
21:24
21:26
21:28
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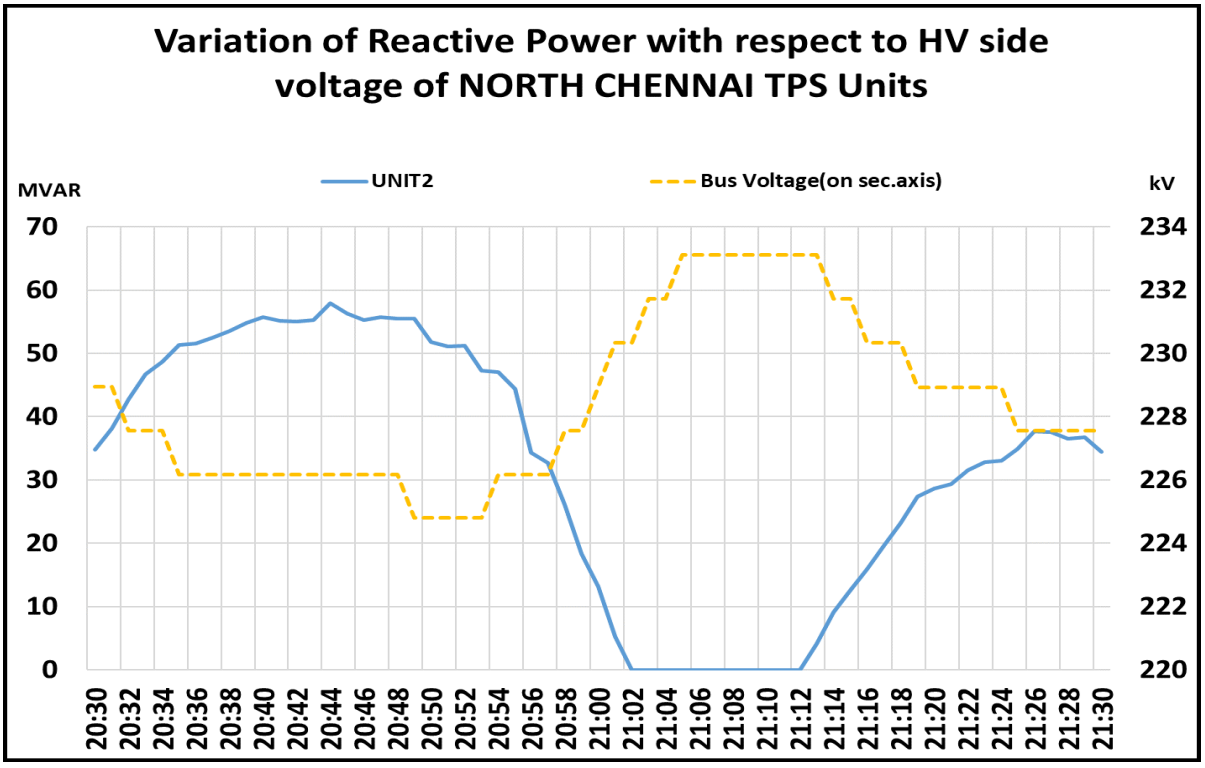
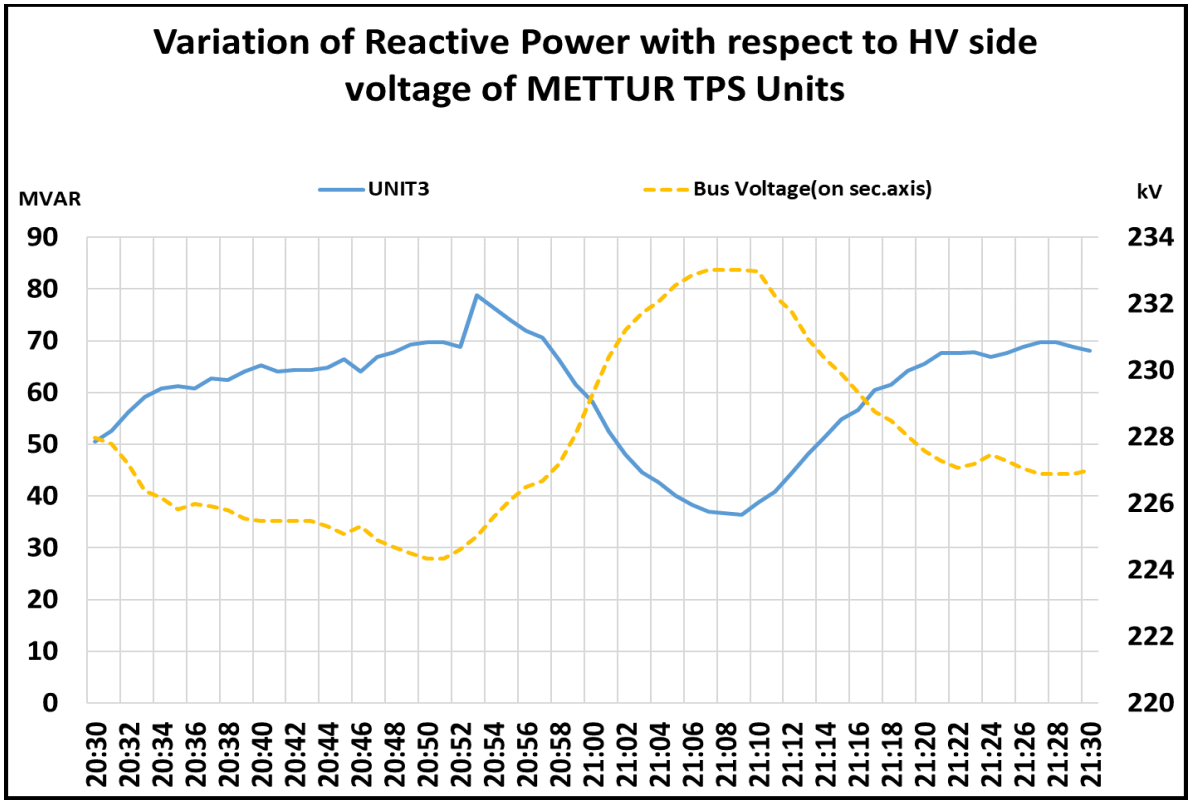

Variation of Reactive Power with respect to HV side voltage of NORTH CHENNAI TPS Units
MVAR
UNIT2
Bus Voltage(on sec.axis)
kV
70
60
50
40
30
20
10
0
234
232
230
228
226
224
222
220
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of METTUR TPS Units
MVAR
UNIT3
Bus Voltage(on sec.axis)
kV
90
80
70
60
50
40
30
20
10
0
234
232
230
228
226
224
222
220
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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21:28
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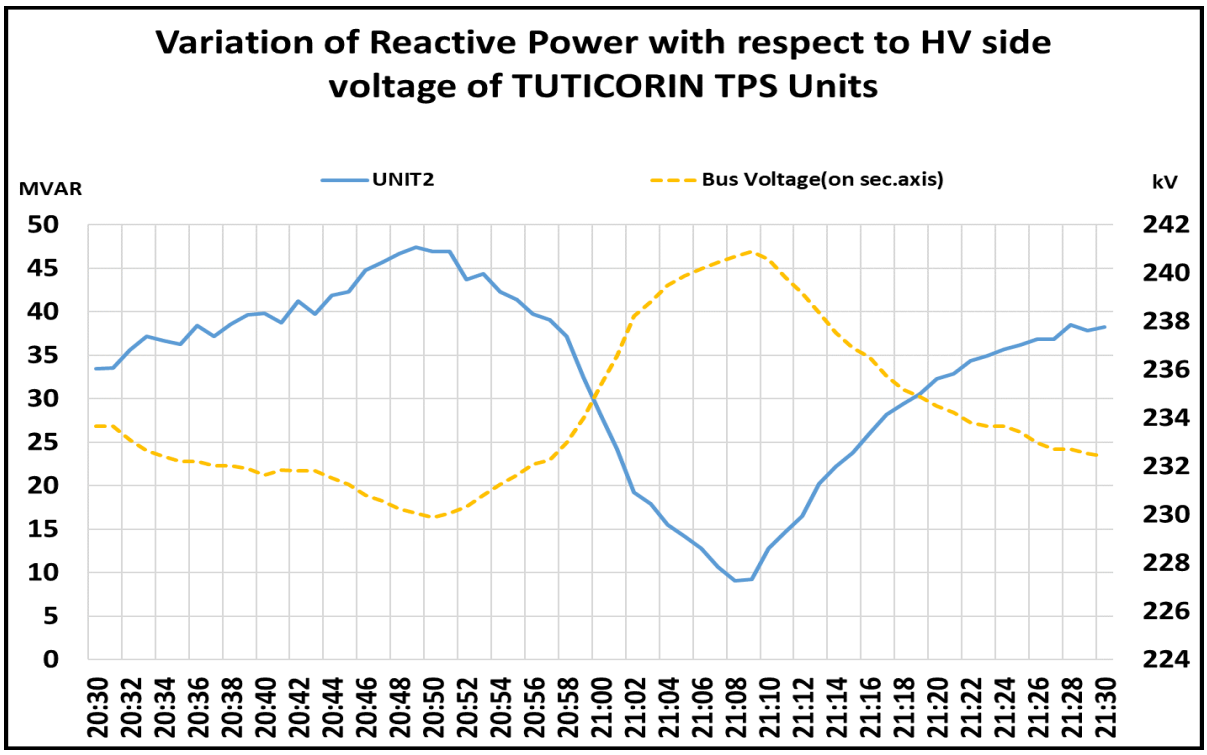
Variation of Reactive Power with respect to HV side voltage of TUTICORIN TPS Units
MVAR
UNIT2
Bus Voltage(on sec.axis)
kV
50
45
40
35
30
25
20
15
10
5
0
242
240
238
236
234
232
230
228
226
224
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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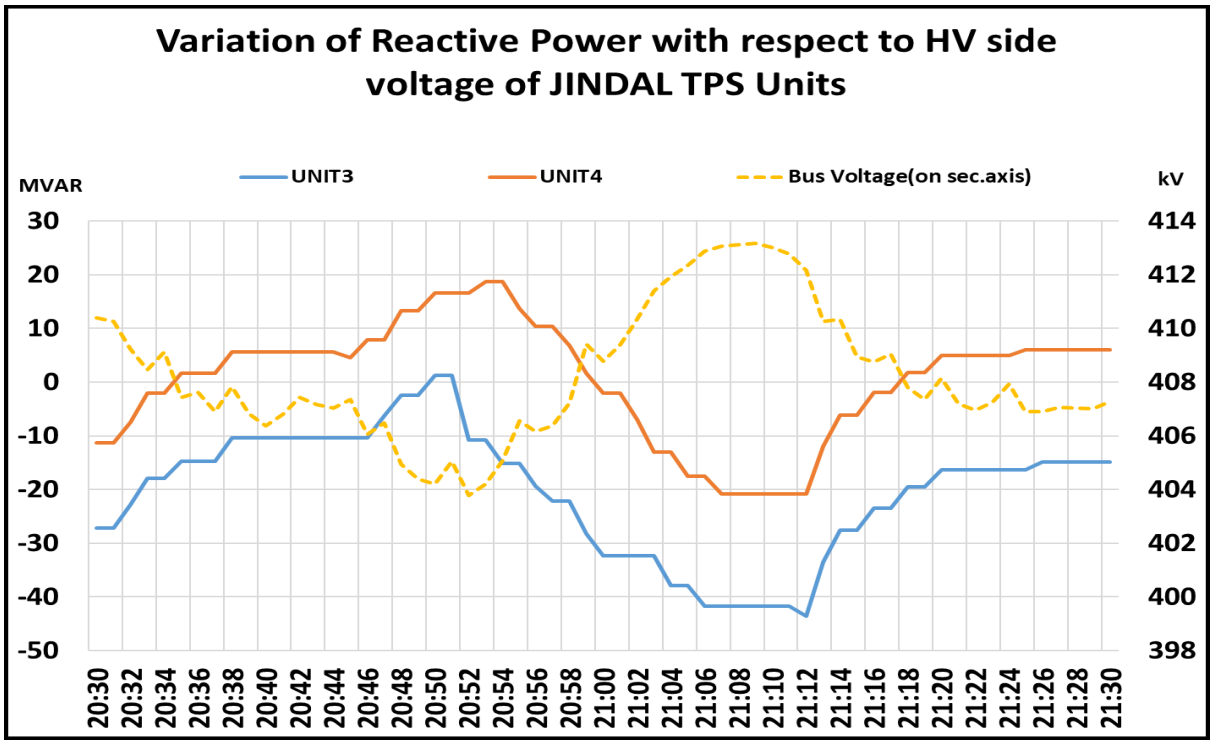
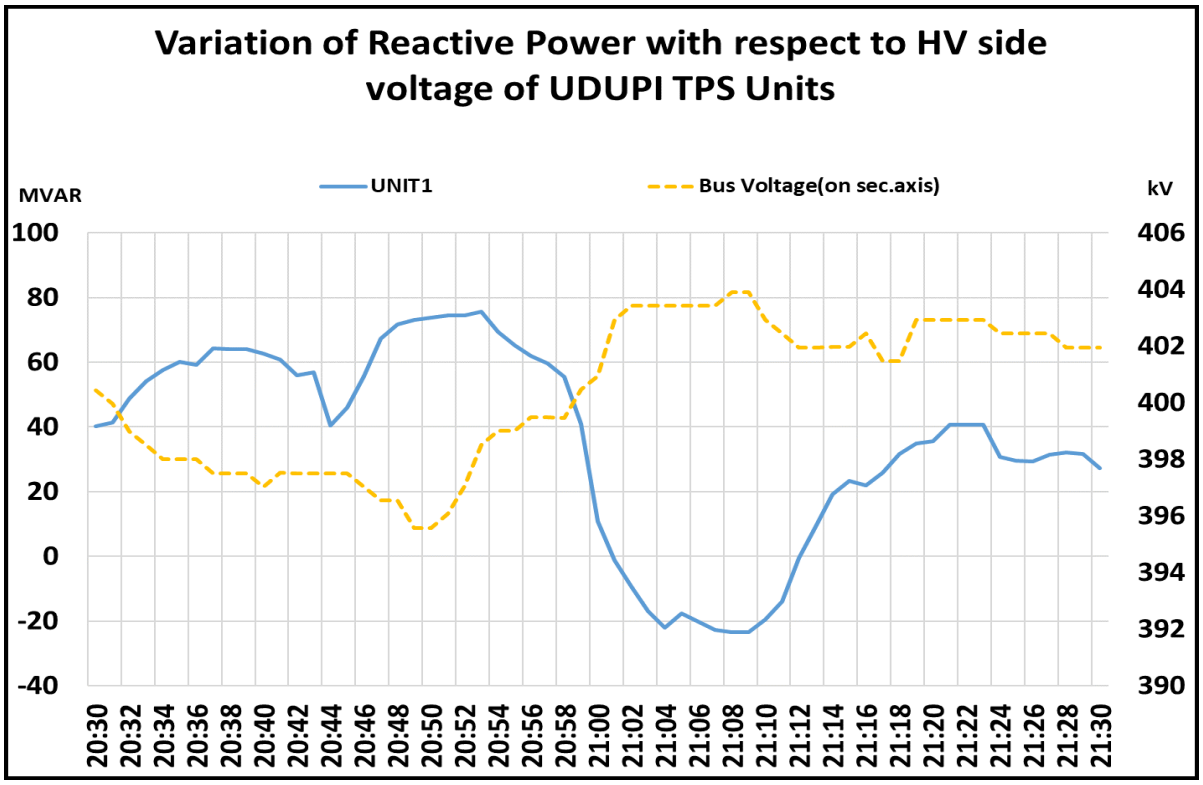
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of JINDAL TPS Units
MVAR
UNIT3
UNIT4
Bus Voltage(on sec.axis)
kV
30
20
10
0
-10
-20
-30
-40
-50
414
412
410
408
406
404
402
400
398
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of UDUPI TPS Units
MVAR
UNIT1
Bus Voltage(on sec.axis)
kV
100
80
60
40
20
0
-20
-40
406
404
402
400
398
396
394
392
390
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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21:22
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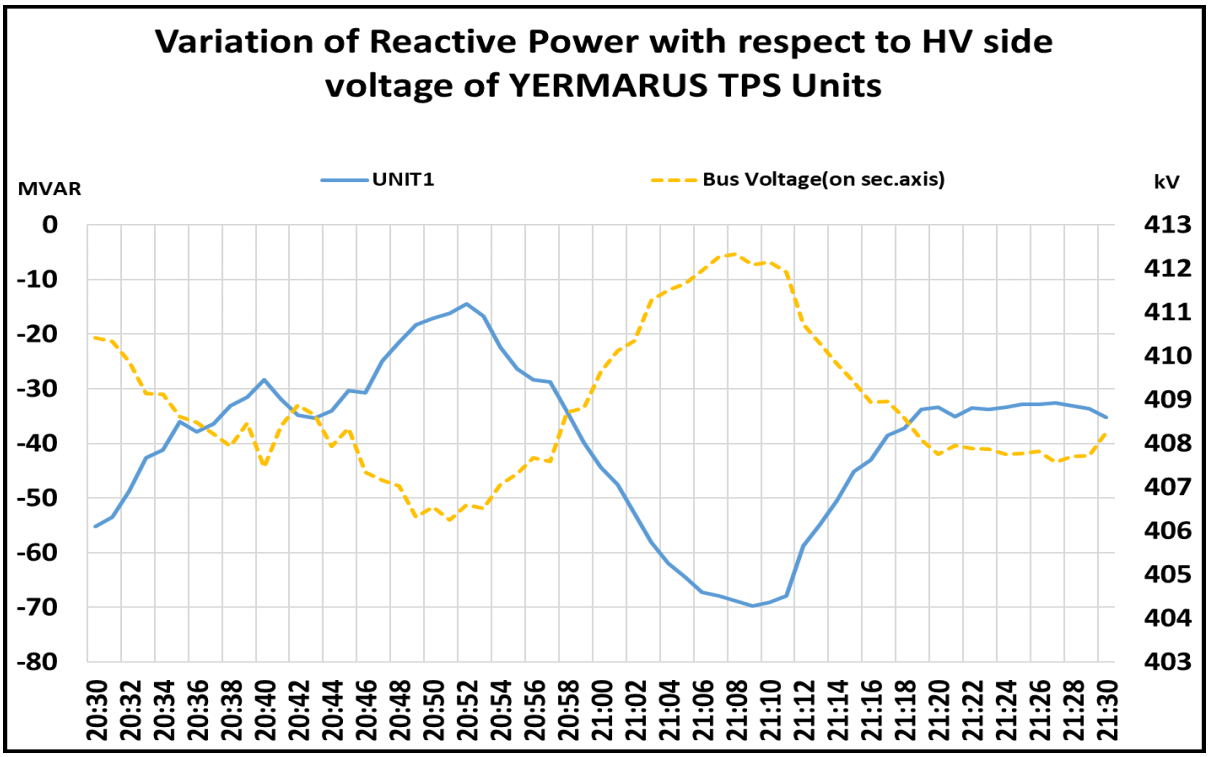
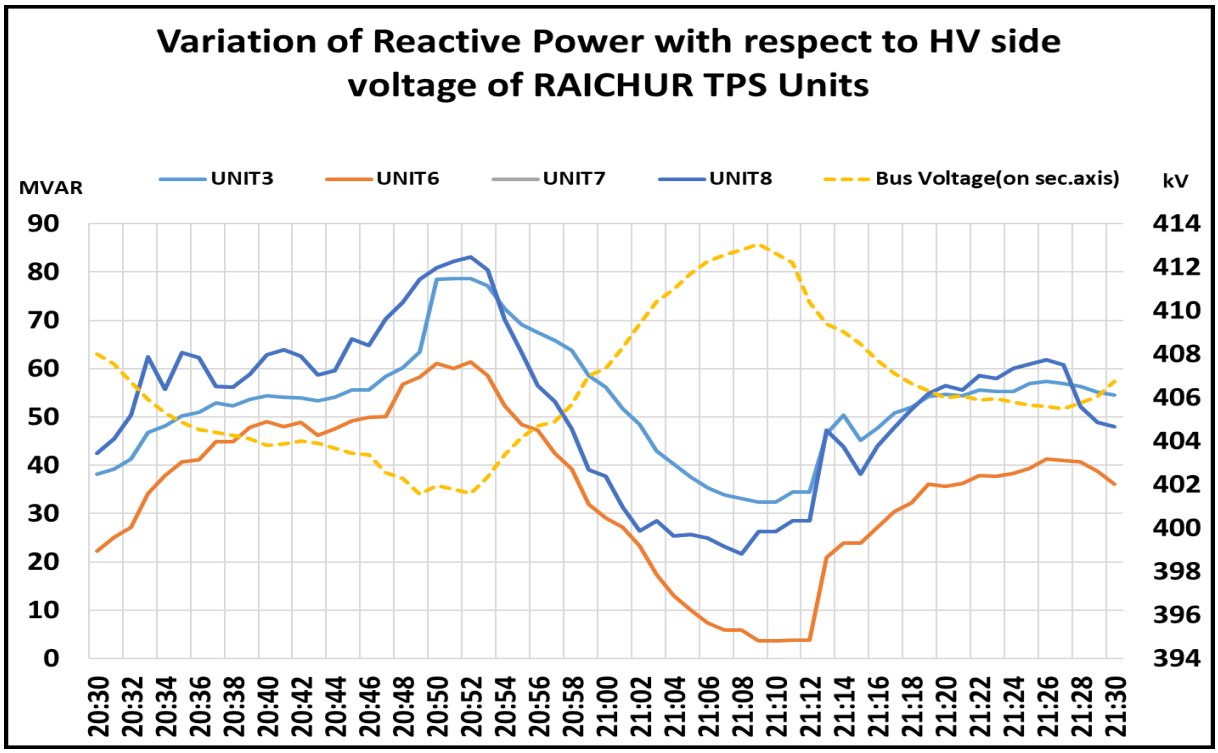
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of YERMARUS TPS Units
MVAR
UNIT1
Bus Voltage(on sec.axis)
kV
0
-10
-20
-30
-40
-50
-60
-70
-80
413
412
411
410
409
408
407
406
405
404
403
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of RAICHUR TPS Units
MVAR
UNIT3
UNIT6
UNIT7
UNIT8
Bus Voltage(on sec.axis)
kV
90
80
70
60
50
40
30
20
10
0
414
412
410
408
406
404
402
400
398
396
394
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
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21:10
21:12
21:14
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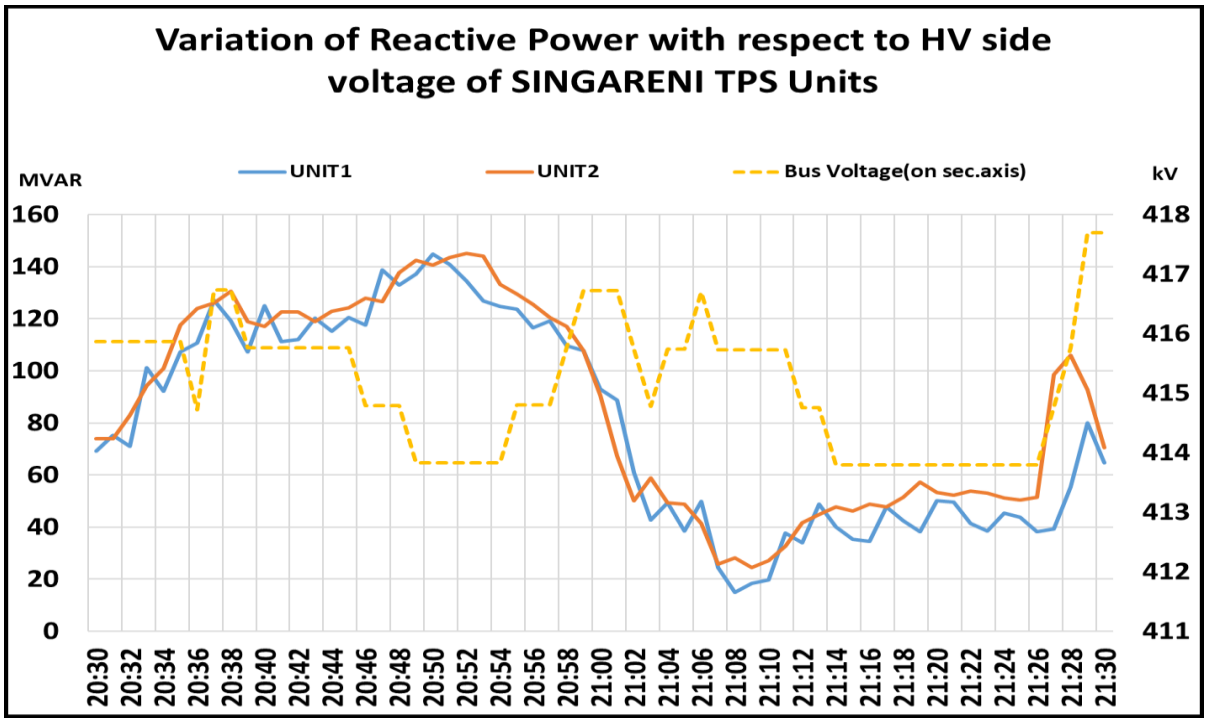
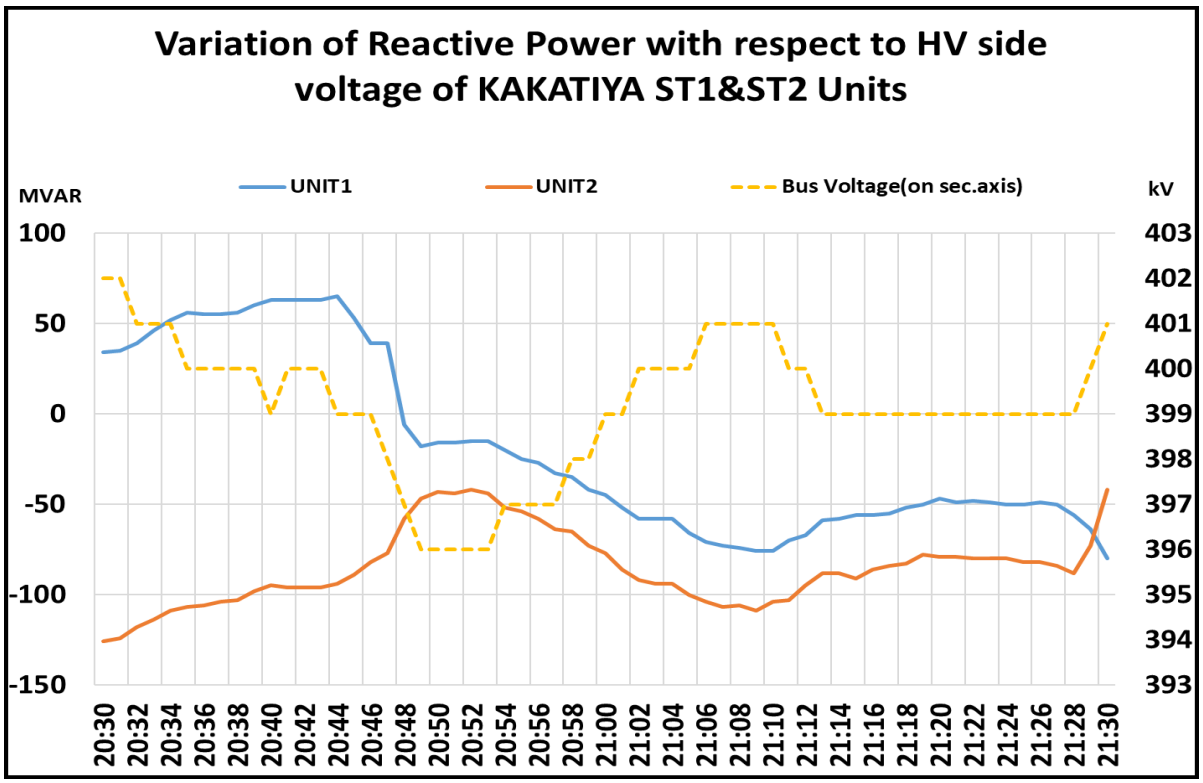
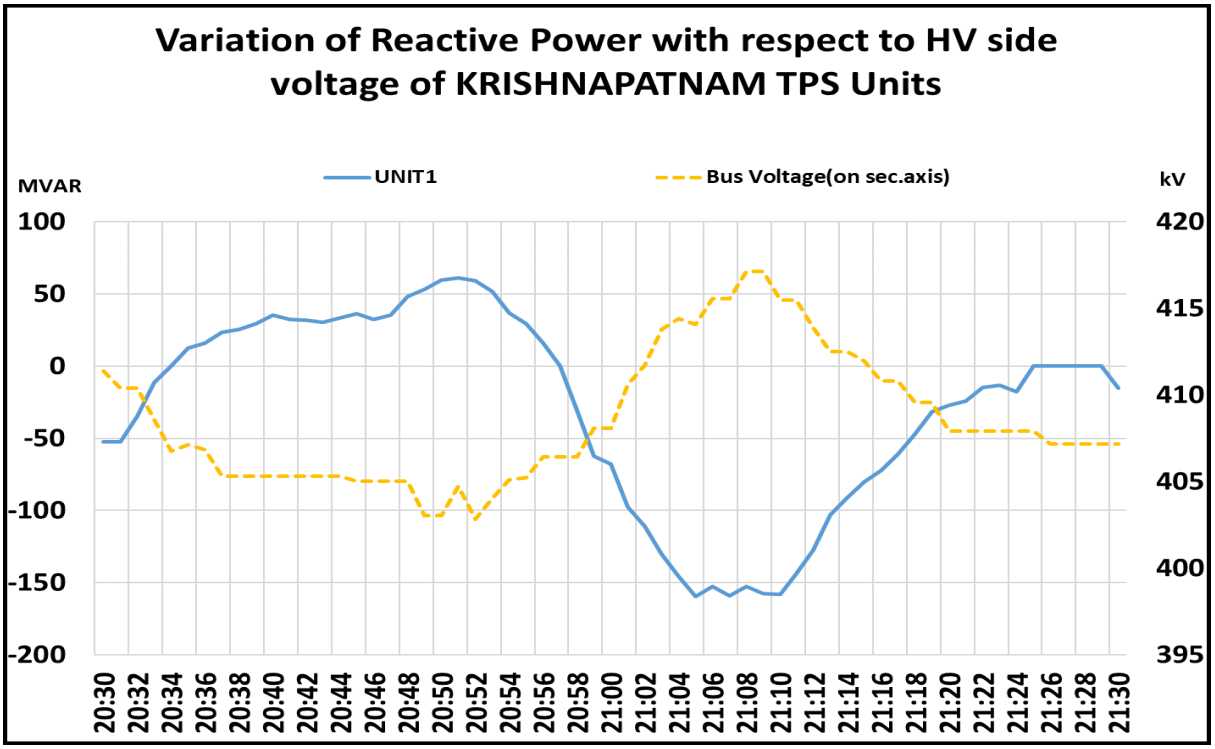
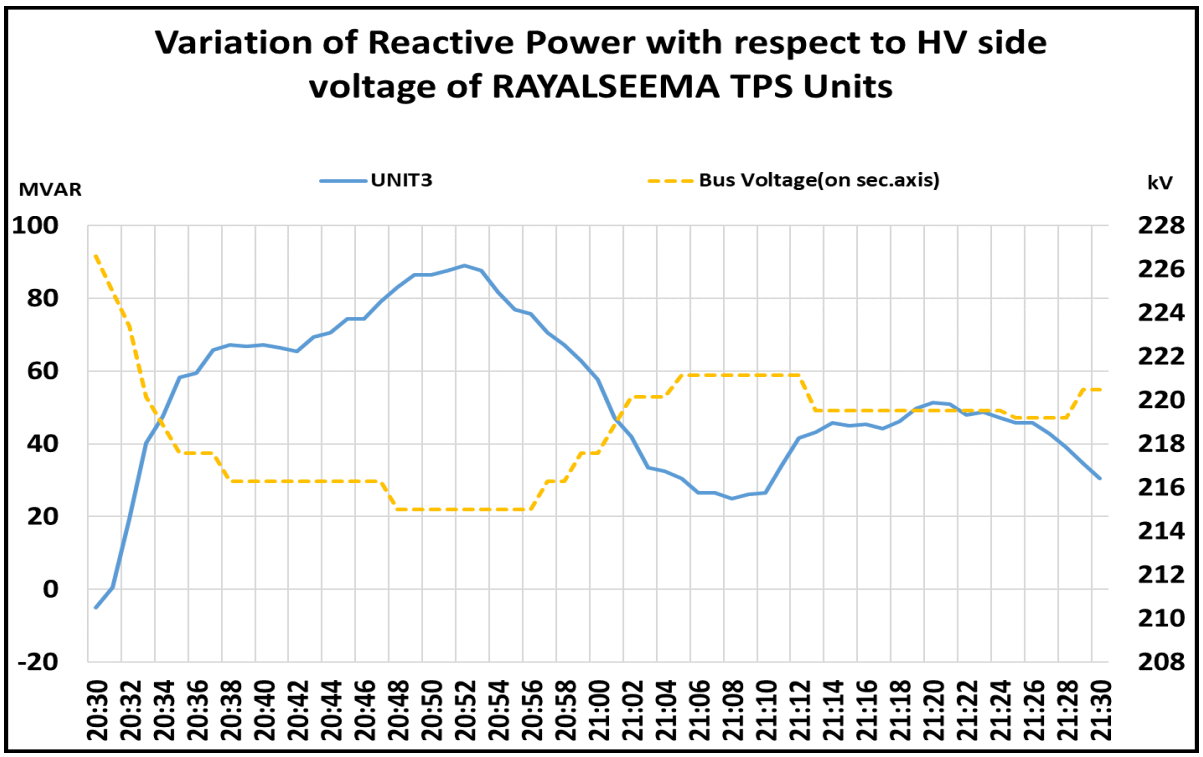
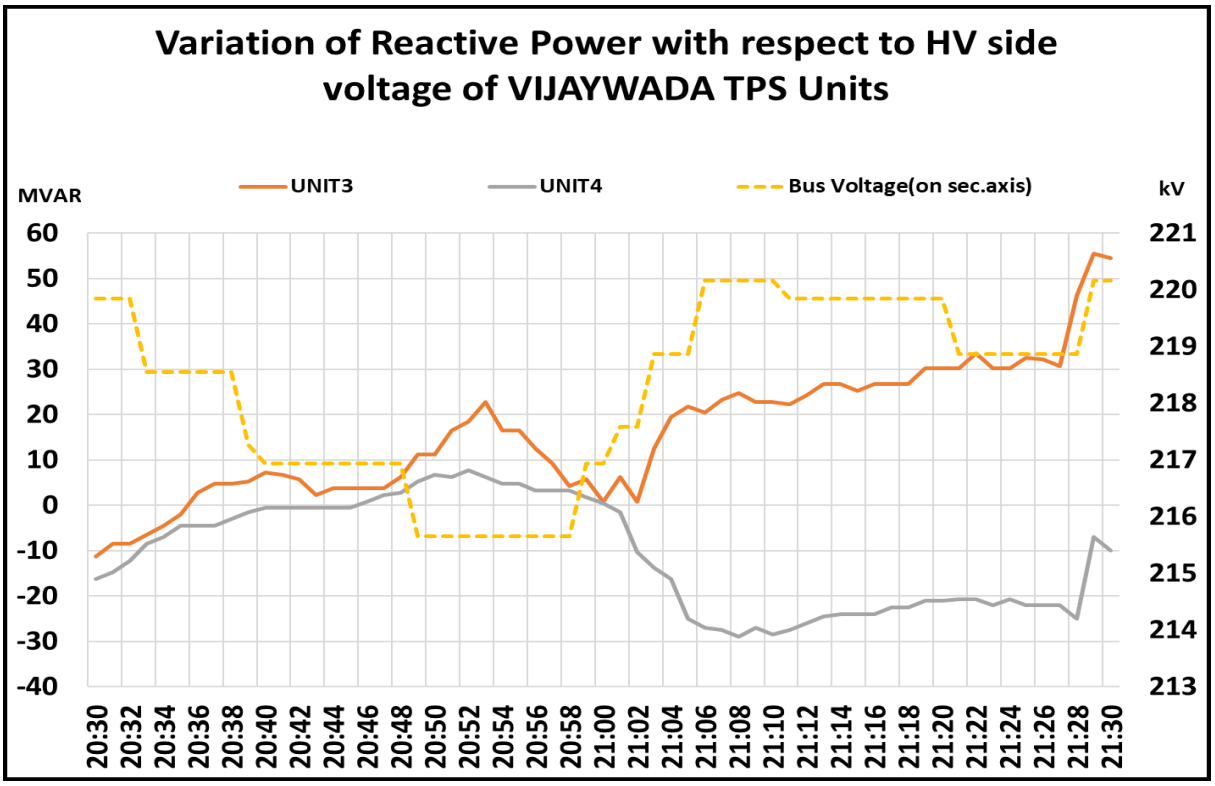
21:18
21:20
21:22
21:24
21:26
21:28
21:30

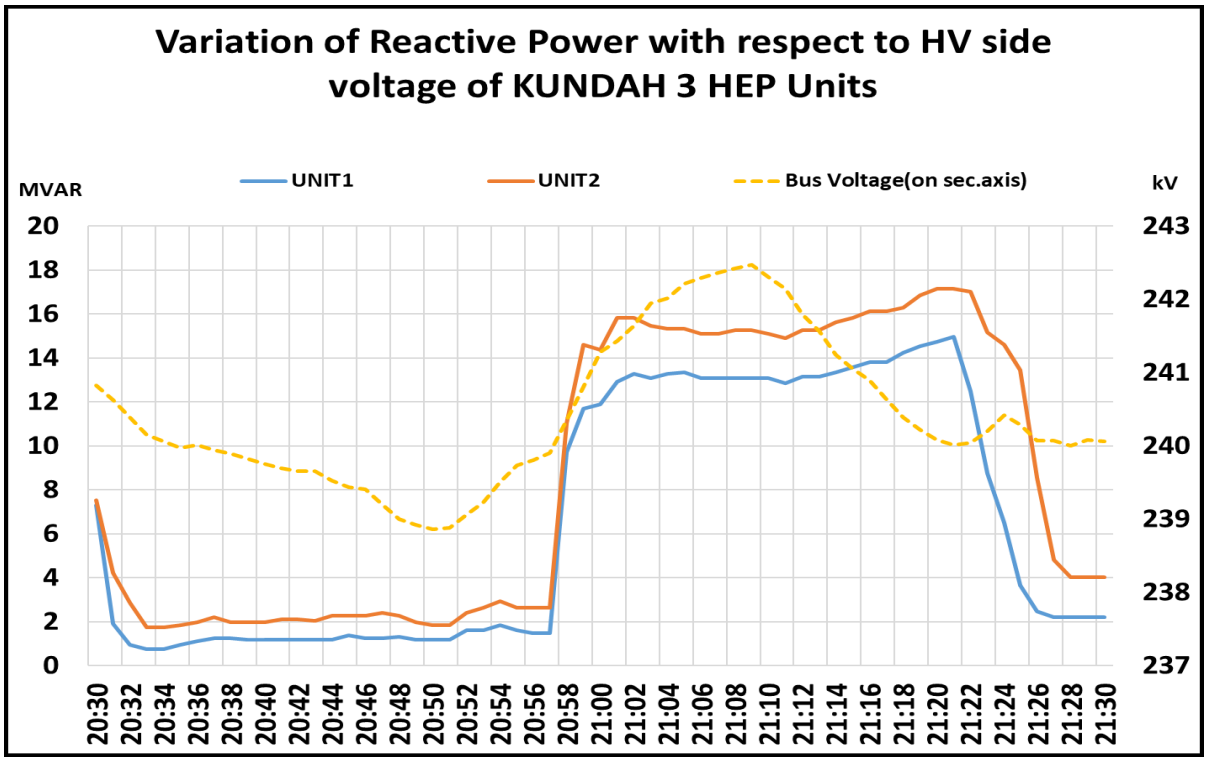

Variation of Reactive Power with respect to HV side voltage of SINGARENI TPS Units
MVAR
UNIT1
UNIT2
Bus Voltage(on sec.axis)
kV
160
140
120
100
80
60
40
20
0
418
417
416
415
414
413
412
411
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

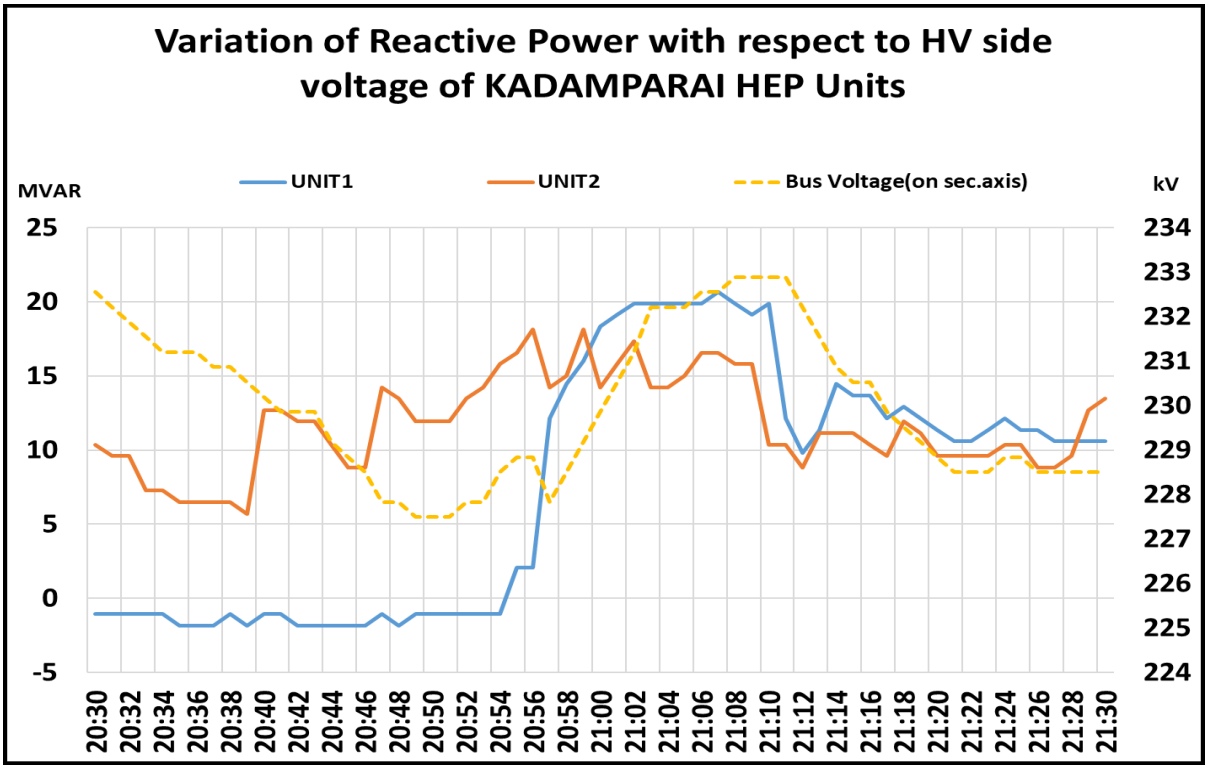

Variation of Reactive Power with respect to HV side voltage of KAKATIYA ST1&ST2 Units
MVAR
UNIT1
UNIT2
Bus Voltage(on sec.axis)
kV
100
50
0
-50
-100
-150
403
402
401
400
399
398
397
396
395
394
393
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

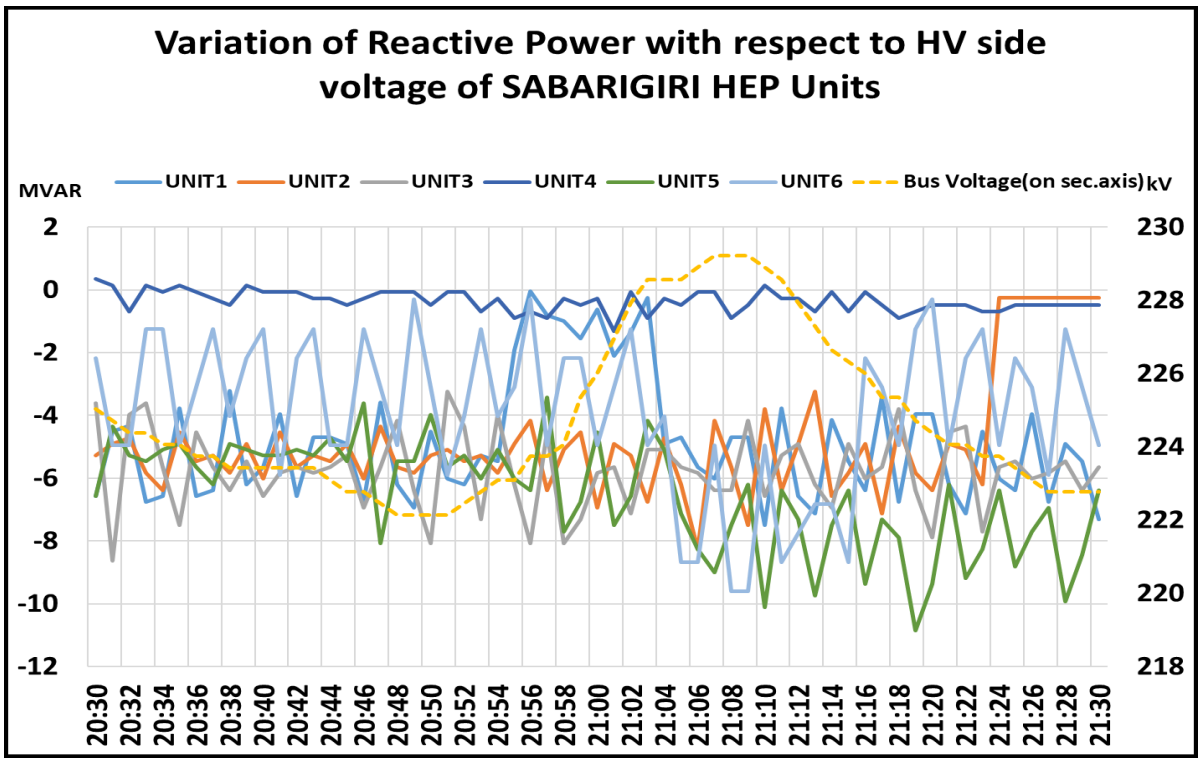

Variation of Reactive Power with respect to HV side voltage of KRISHNAPATNAM TPS Units
MVAR
UNIT1
Bus Voltage(on sec.axis)
kV
100
50
0
-50
-100
-150
-200
420
415
410
405
400
395
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

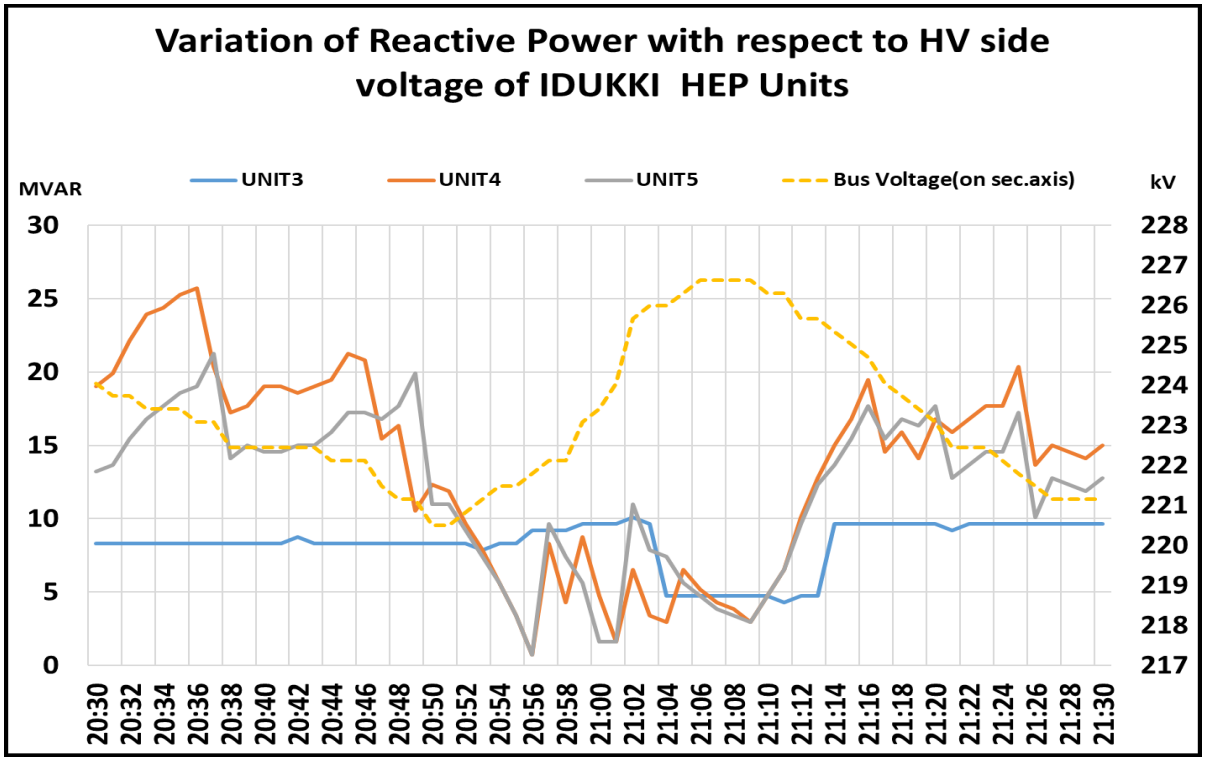

Variation of Reactive Power with respect to HV side voltage of RAYALSEEMA TPS Units
MVAR
UNIT3
Bus Voltage(on sec.axis)
kV
100
80
60
40
20
0
-20
228
226
224
222
220
218
216
214
212
210
208
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of VIJAYWADA TPS Units
MVAR
UNIT3
UNIT4
Bus Voltage(on sec.axis)
kV
60
50
40
30
20
10
0
-10
-20
-30
-40
221
220
219
218
217
216
215
214
213
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of KUNDAH 3 HEP Units
MVAR
UNIT1
UNIT2
Bus Voltage(on sec.axis)
kV
20
18
16
14
12
10
8
6
4
2
0
243
242
241
240
239
238
237
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of KADAMPARAI HEP Units
MVAR
UNIT1
UNIT2
Bus Voltage(on sec.axis)
kV
25
20
15
10
5
0
-5
234
233
232
231
230
229
228
227
226
225
224
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of SABARIGIRI HEP Units
MVAR
UNIT1
UNIT2
UNIT3
UNIT4
UNIT5
UNIT6
Bus Voltage(on sec.axis)
kV
2
0
-2
-4
-6
-8
-10
-12
230
228
226
224
222
220
218
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of IDUKKI HEP Units
MVAR
UNIT3
UNIT4
UNIT5
Bus Voltage(on sec.axis)
kV
30
25
20
15
10
5
0
228
227
226
225
224
223
222
221
220
219
218
217
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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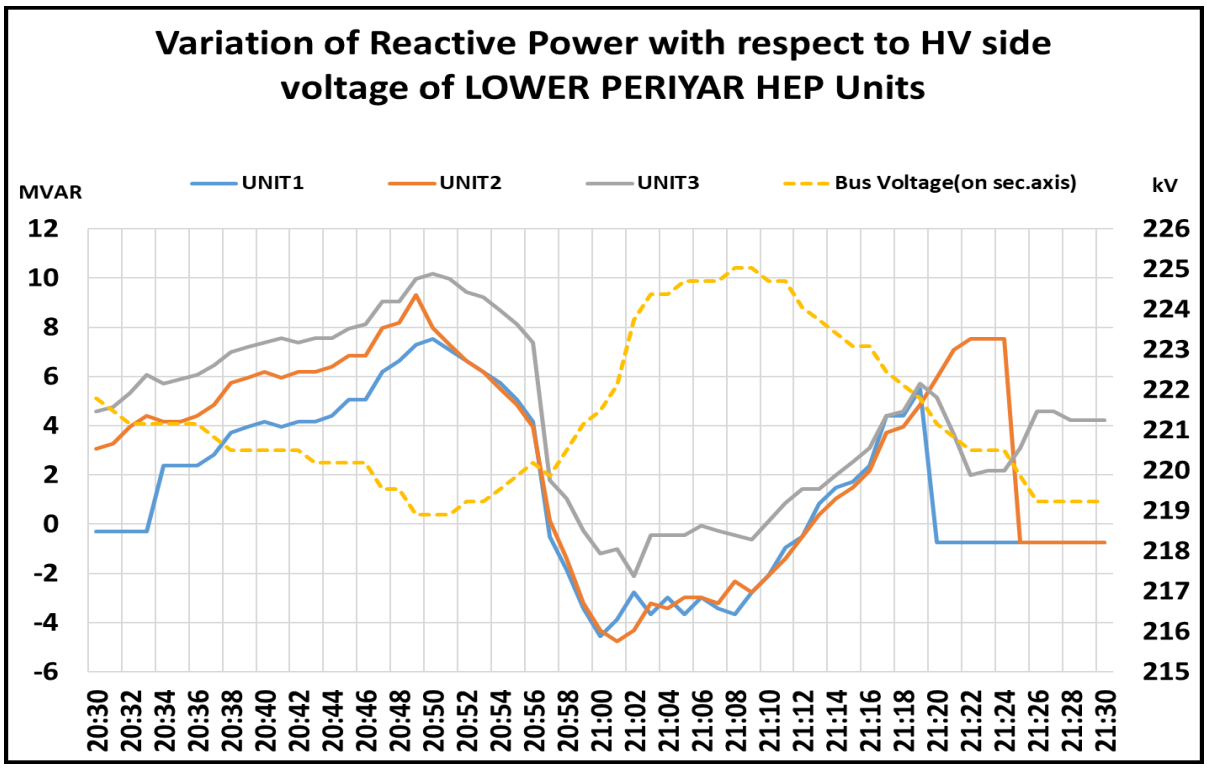
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of LOWER PERIYAR HEP Units
MVAR
UNIT1
UNIT2
UNIT3
Bus Voltage(on sec.axis)
kV
12
10
8
6
4
2
0
-2
-4
-6
226
225
224
223
222
221
220
219
218
217
216
215
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
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21:18
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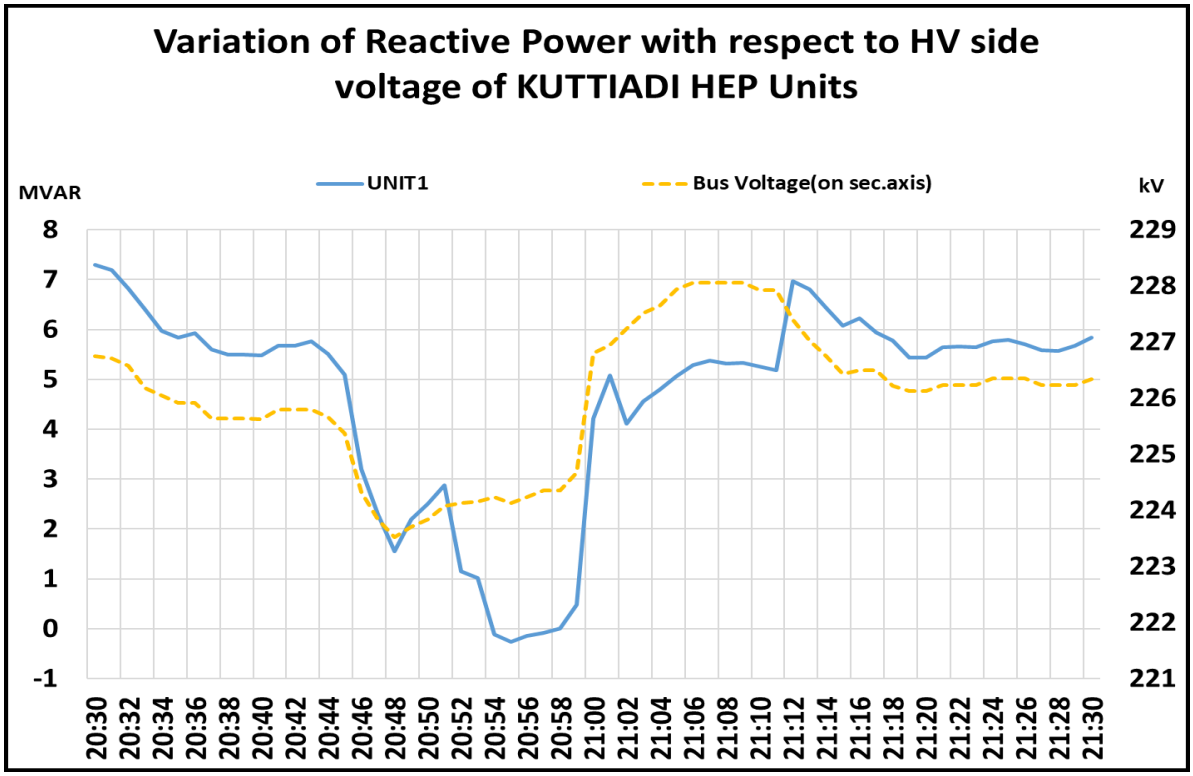
Variation of Reactive Power with respect to HV side voltage of KUTTIADI HEP Units
MVAR
UNIT1
Bus Voltage(on sec.axis)
kV
8
7
6
5
4
3
2
1
0
-1
229
228
227
226
225
224
223
222
221
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
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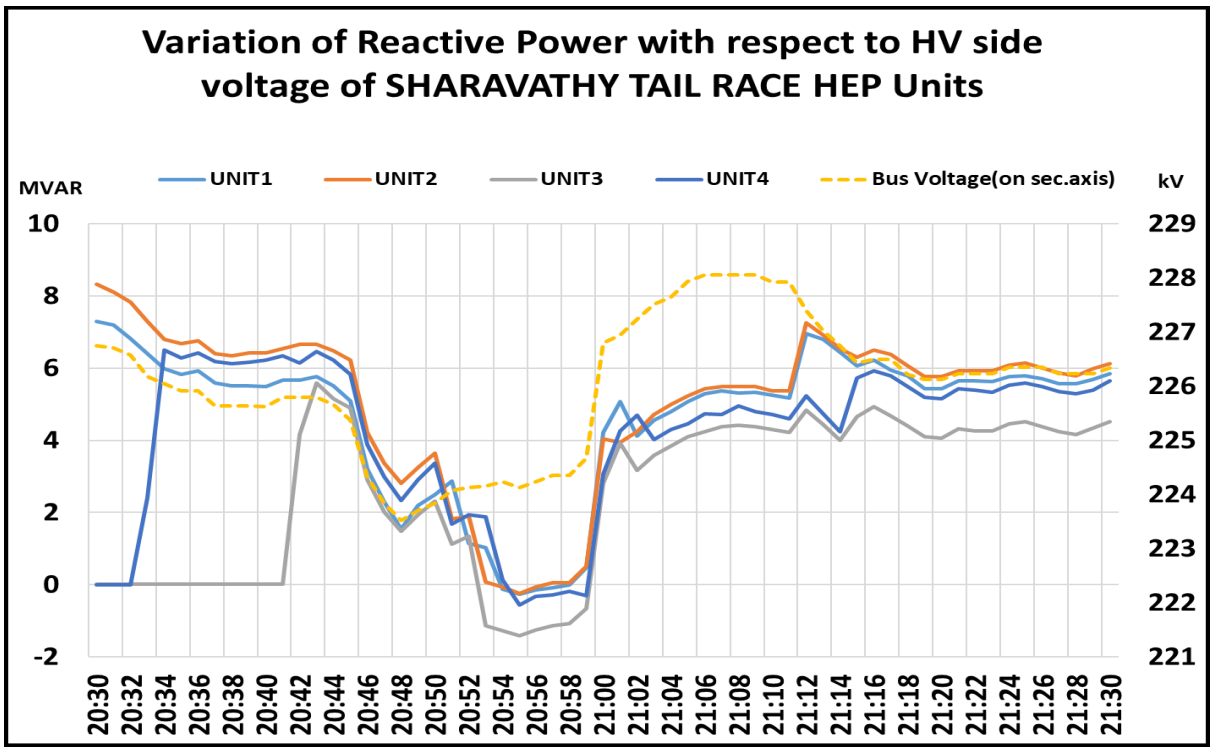
Variation of Reactive Power with respect to HV side voltage of SHARAVATHY TAIL RACE HEP Units
MVAR
UNIT1
UNIT2
UNIT3
UNIT4
Bus Voltage(on sec.axis)
kV
10
8
6
4
2
0
-2
229
228
227
226
225
224
223
222
221
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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21:18
21:20
21:22
21:24
21:26
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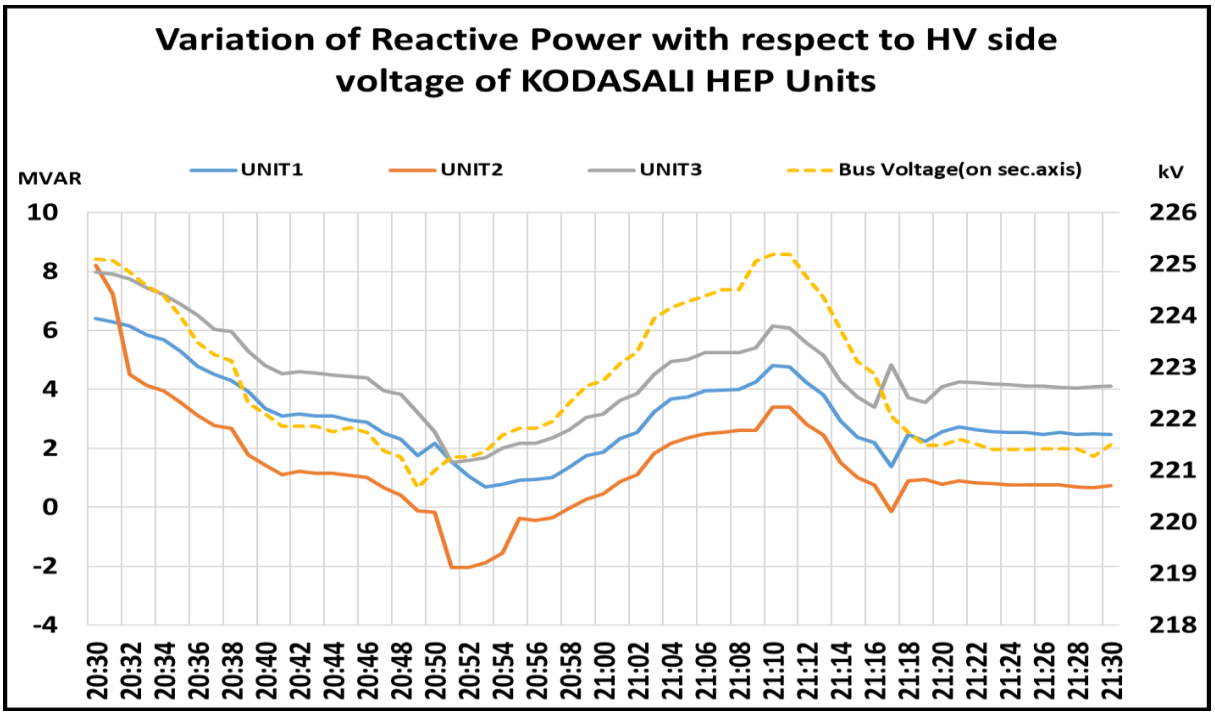
Variation of Reactive Power with respect to HV side voltage of KODASALI HEP Units
MVAR
UNIT1
UNIT2
UNIT3
Bus Voltage(on sec.axis)
kV
10
8
6
4
2
0
-2
-4
226
225
224
223
222
221
220
219
218
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
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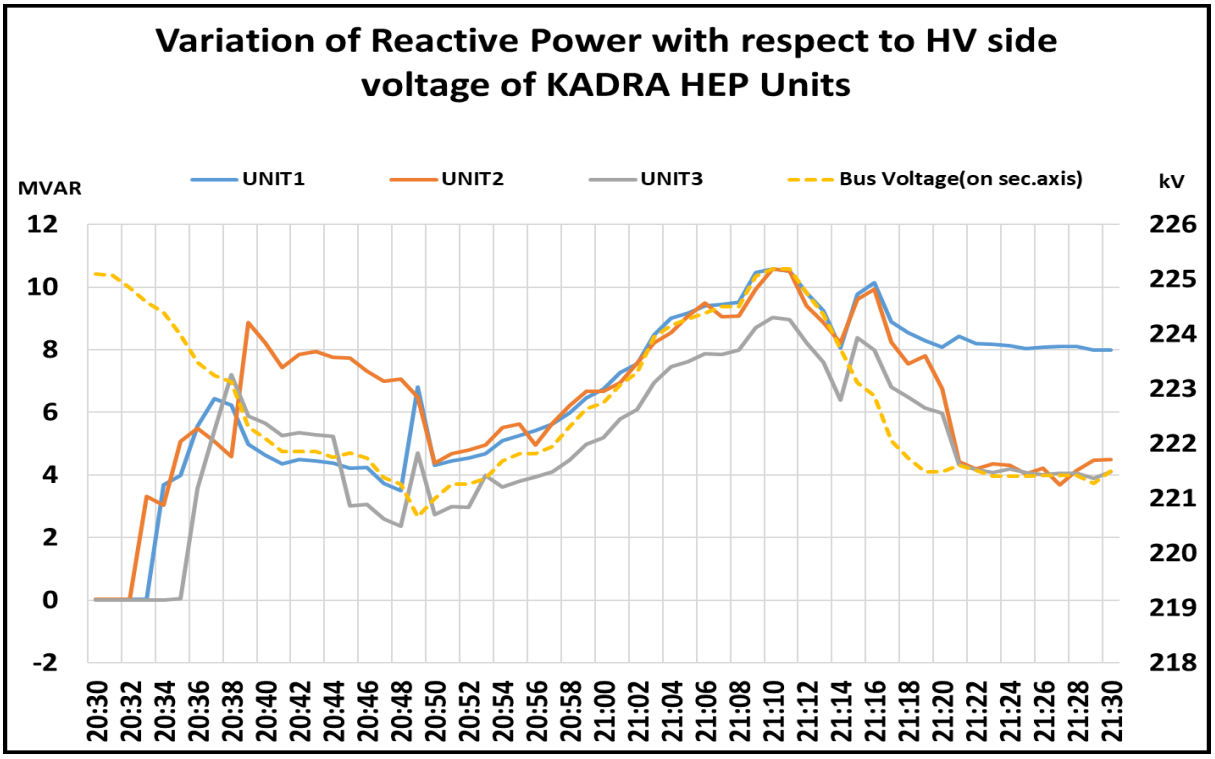
21:30


Variation of Reactive Power with respect to HV side voltage of KADRA HEP Units
MVAR
UNIT1
UNIT2
UNIT3
Bus Voltage(on sec.axis)
kV
12
10
8
6
4
2
0
-2
226
225
224
223
222
221
220
219
218
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
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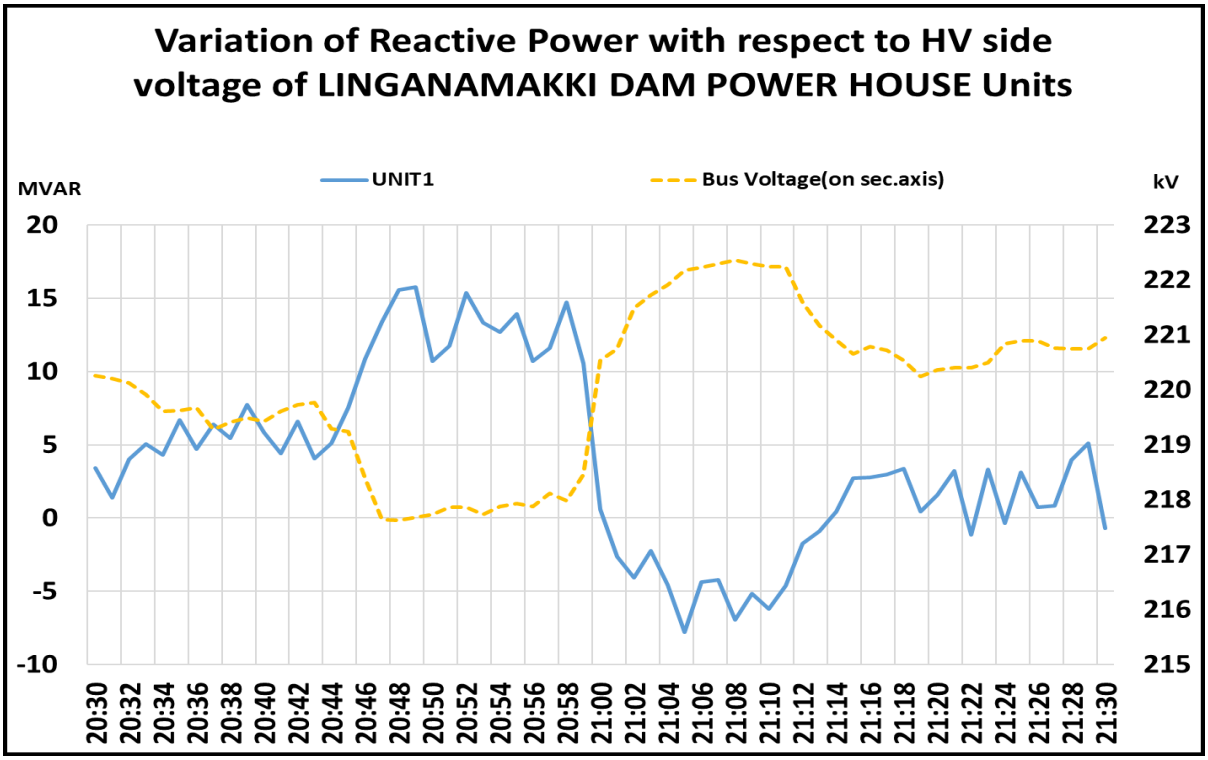
Variation of Reactive Power with respect to HV side voltage of LINGANAMAKKI DAM POWER HOUSE Units
MVAR
UNIT1
Bus Voltage(on sec.axis)
kV
20
15
10
5
0
-5
-10
223
222
221
220
219
218
217
216
215
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
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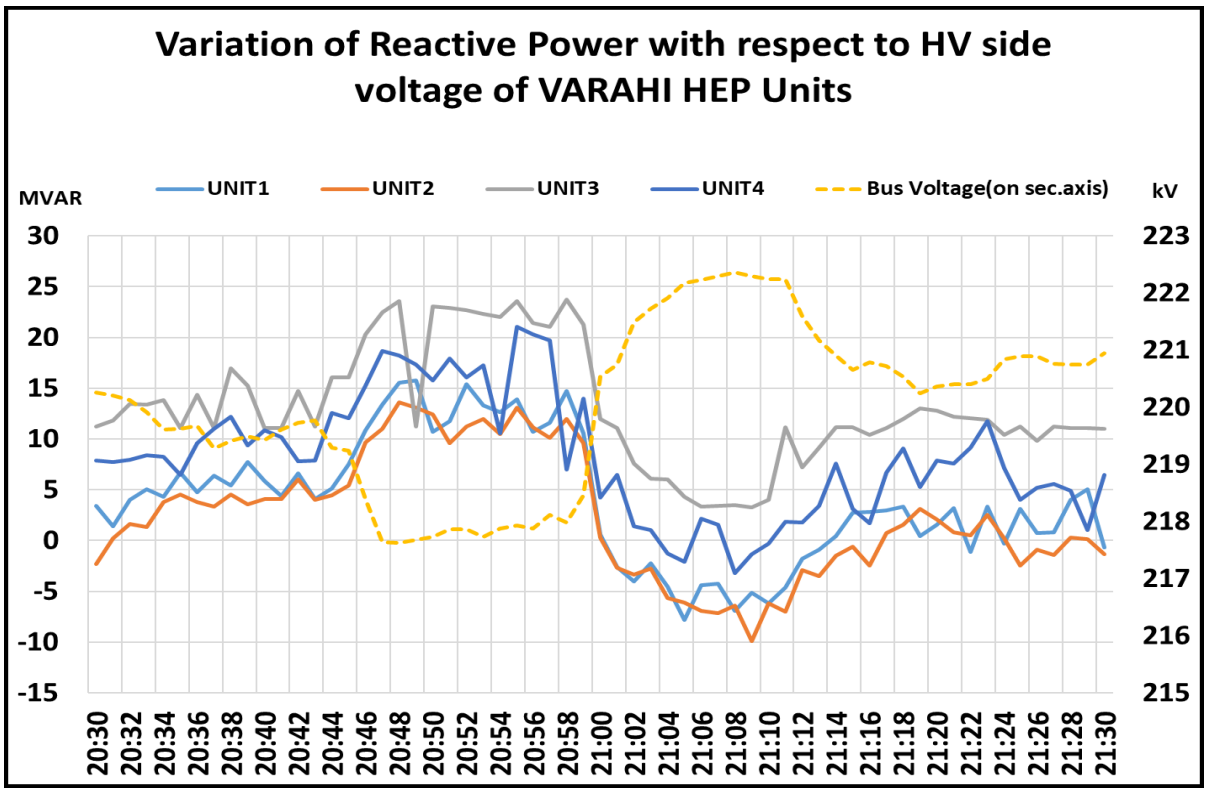
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of VARAHI HEP Units
MVAR
UNIT1
UNIT2
UNIT3
UNIT4
Bus Voltage(on sec.axis)
kV
30
25
20
15
10
5
0
-5
-10
-15
223
222
221
220
219
218
217
216
215
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
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21:14
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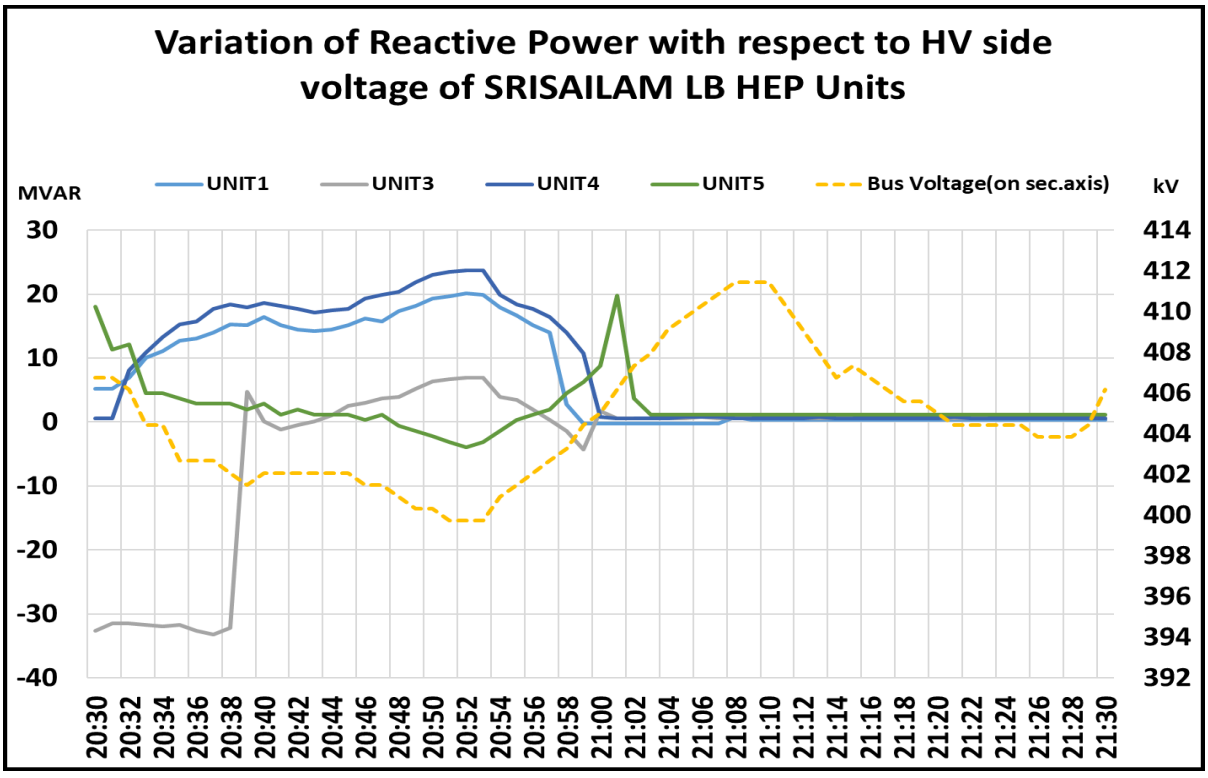
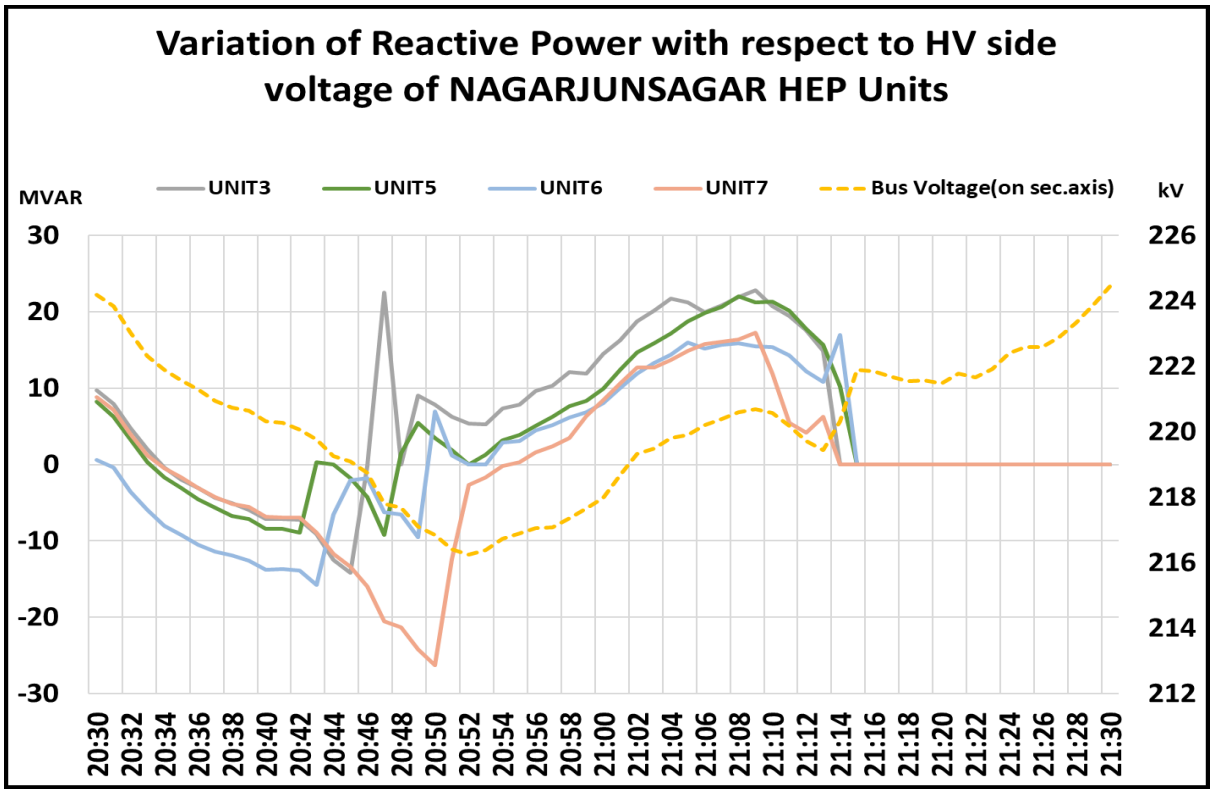
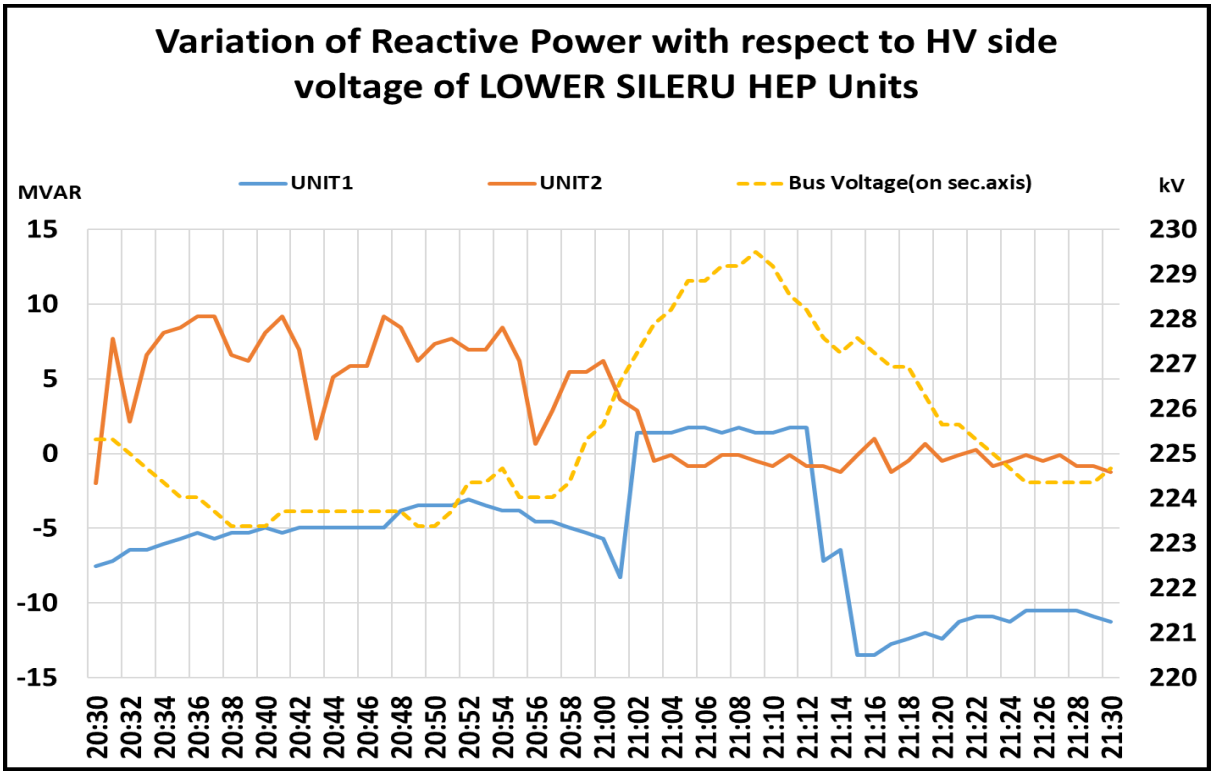
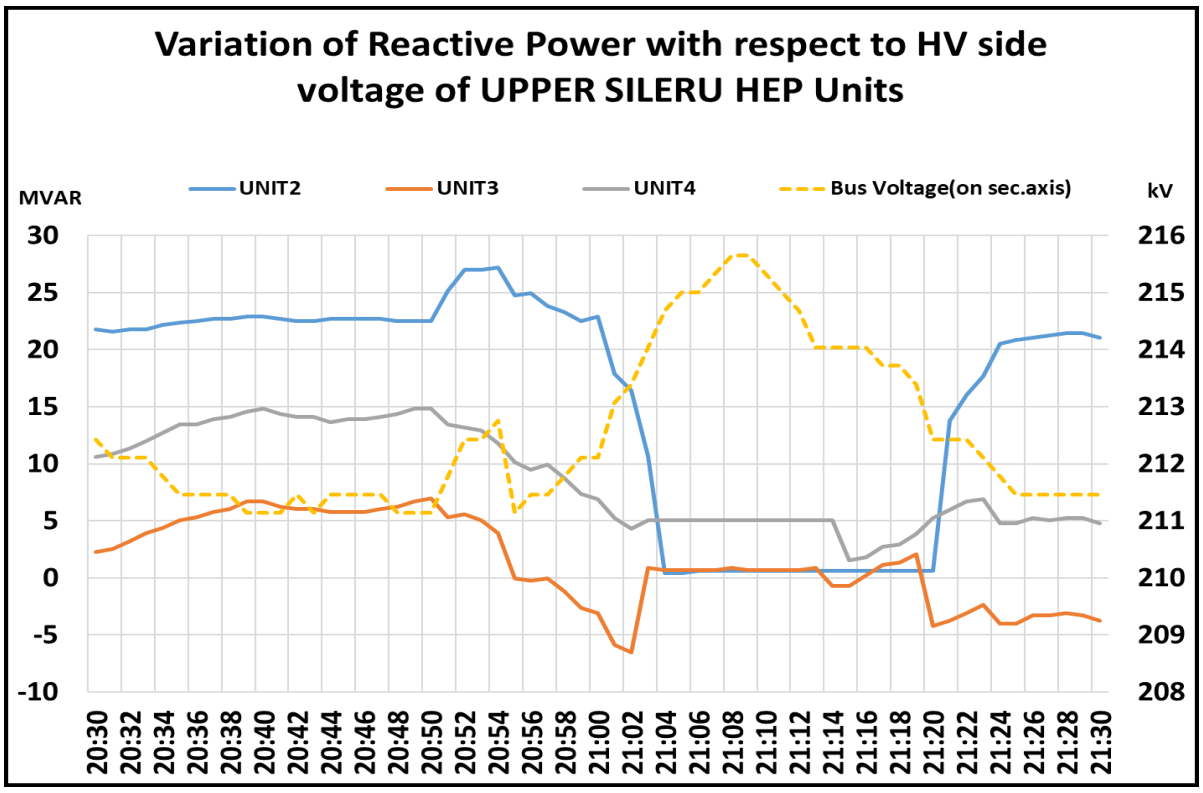
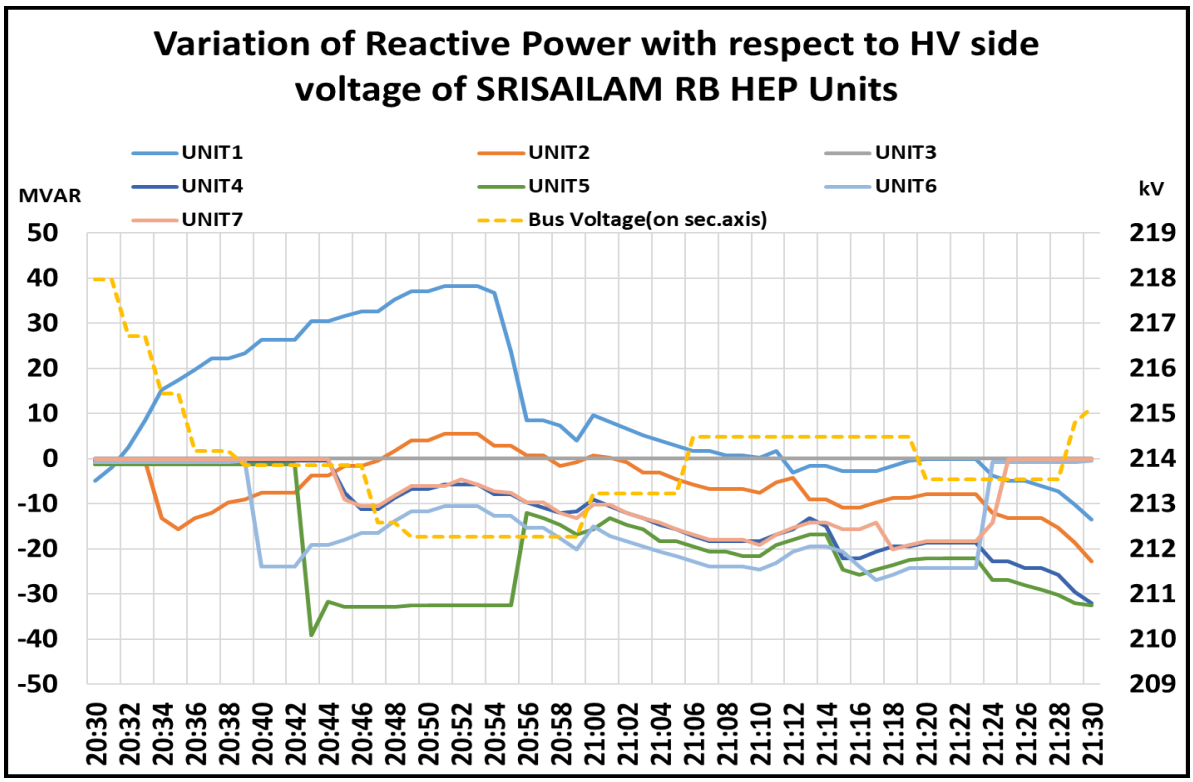
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of SRISAILAM LB HEP Units
MVAR
UNIT1
UNIT3
UNIT4
UNIT5
Bus Voltage(on sec.axis)
kV
30
20
10
0
-10
-20
-30
-40
414
412
410
408
406
404
402
400
398
396
394
392
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of NAGARJUNSAGAR HEP Units
MVAR
UNIT3
UNIT5
UNIT6
UNIT7
Bus Voltage(on sec.axis)
kV
30
20
10
0
-10
-20
-30
226
224
222
220
218
216
214
212
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of LOWER SILERU HEP Units
MVAR
UNIT1
UNIT2
Bus Voltage(on sec.axis)
kV
15
10
5
0
-5
-10
-15
230
229
228
227
226
225
224
223
222
221
220
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of UPPER SILERU HEP Units
MVAR
kV
UNIT2
UNIT3
UNIT4
Bus Voltage(on sec.axis)
30
25
20
15
10
5
0
-5
-10
216
215
214
213
212
211
210
209
208
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of SRISAILAM RB HEP Units
MVAR
kV
UNIT1
UNIT2
UNIT3
UNIT4
UNIT5
UNIT6
UNIT7
Bus Voltage(on sec.axis)
50
40
30
20
10
0
-10
-20
-30
-40
-50
219
218
217
216
215
214
213
212
211
210
209
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
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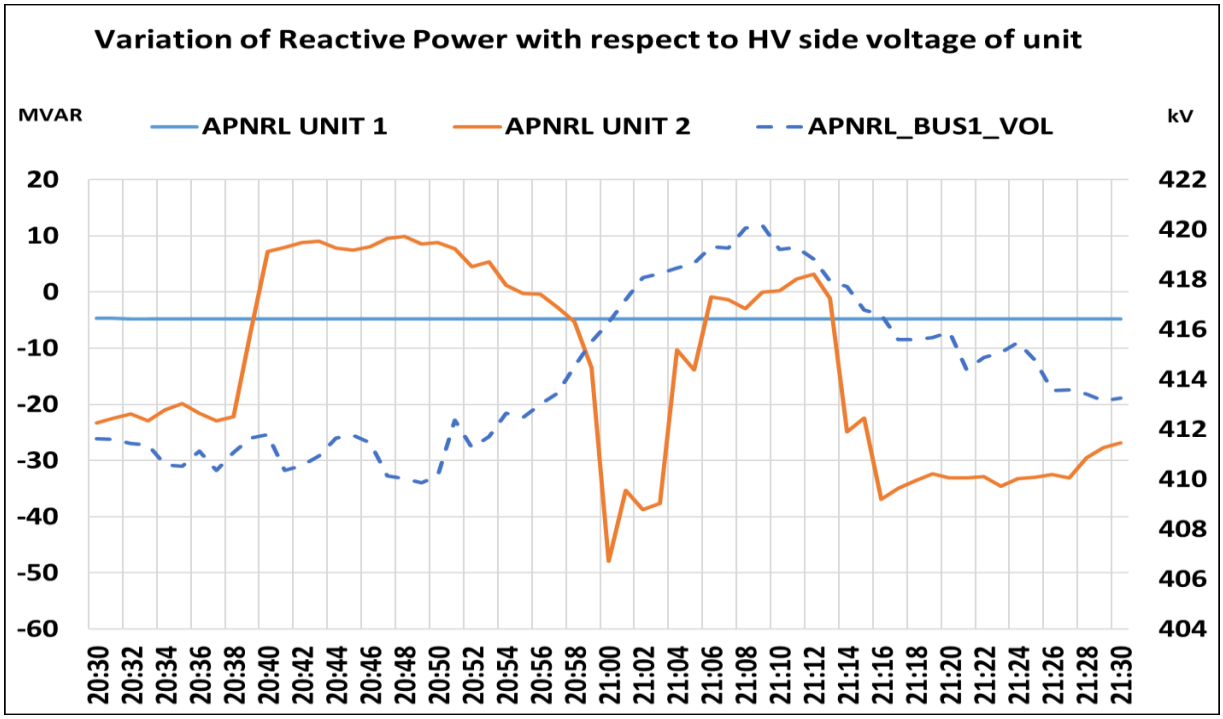
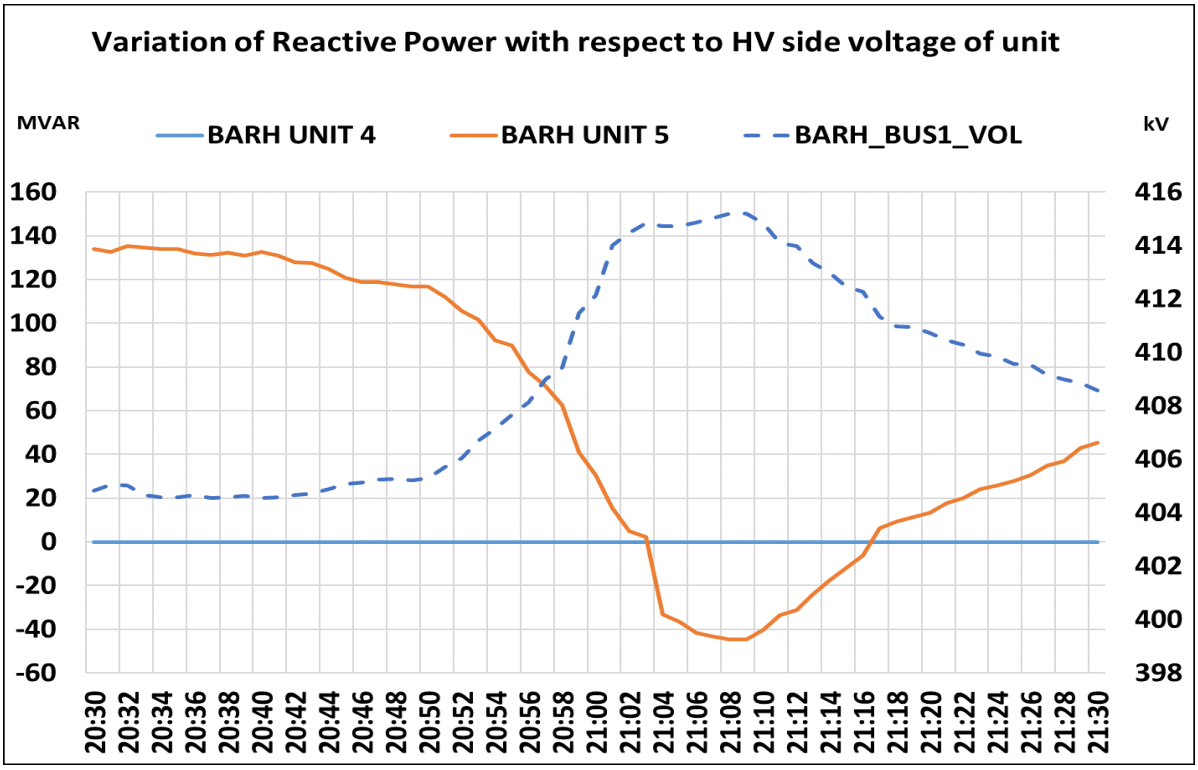
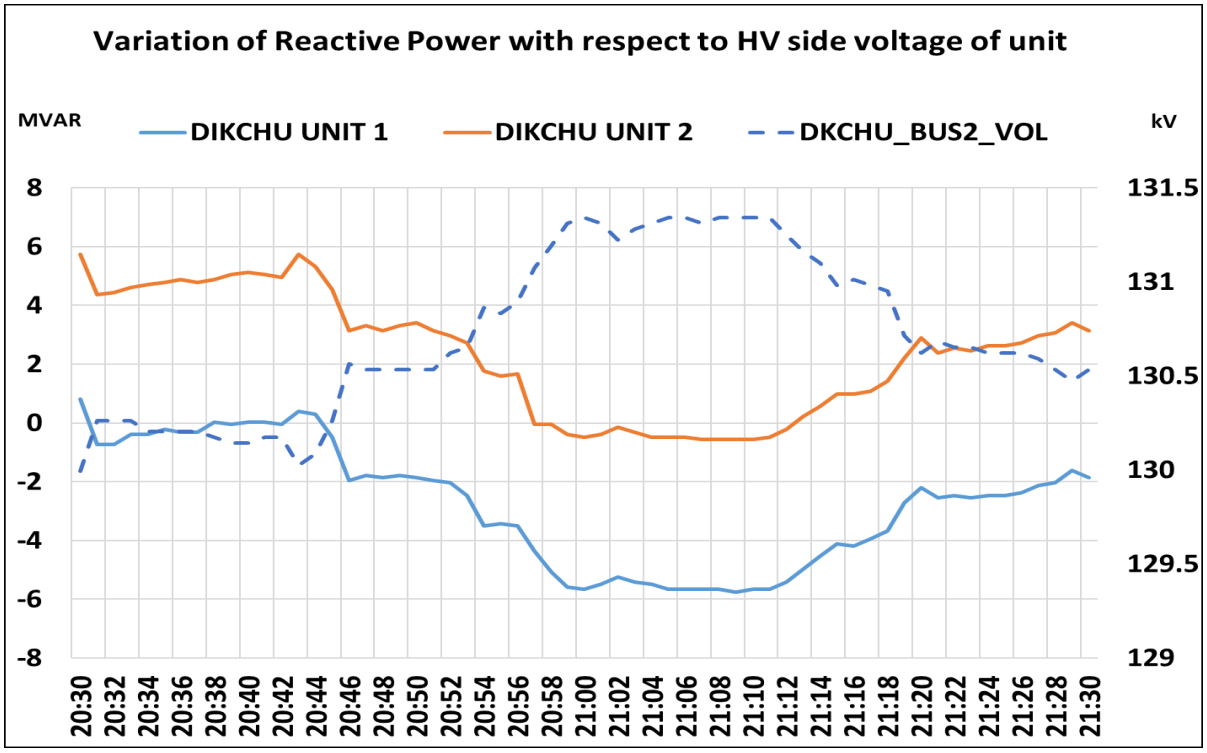
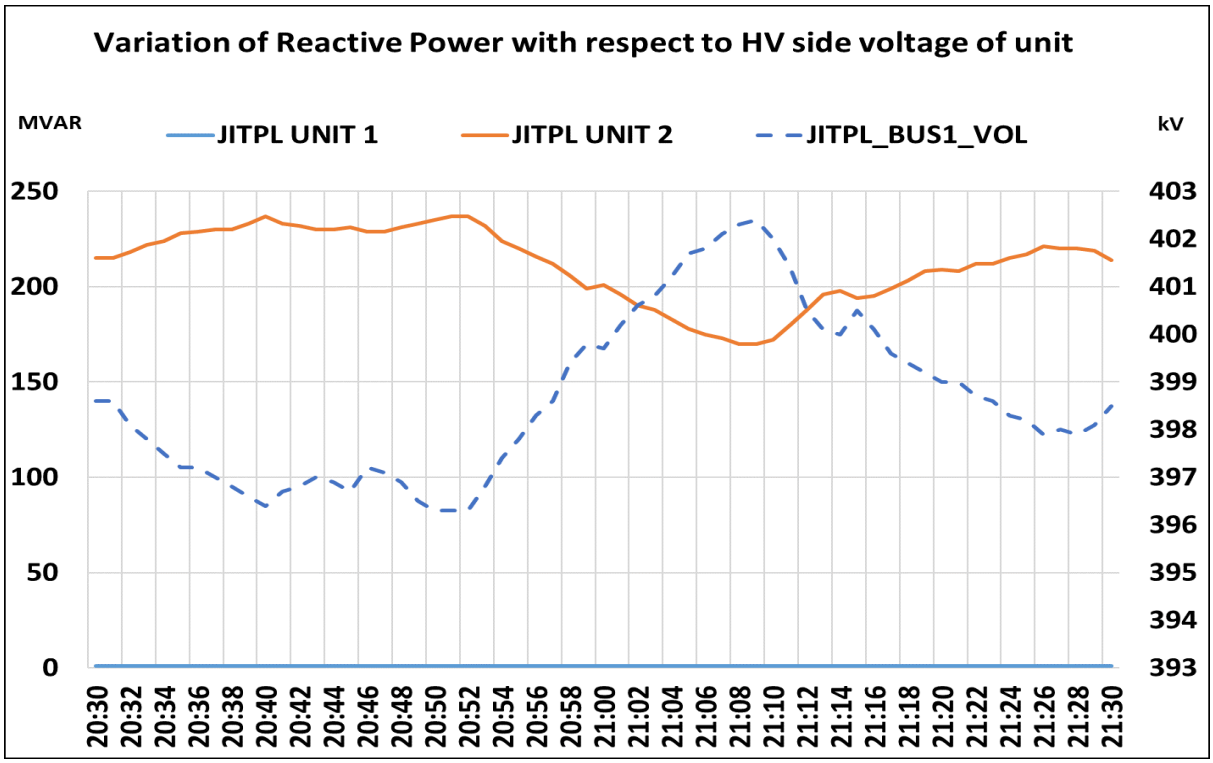
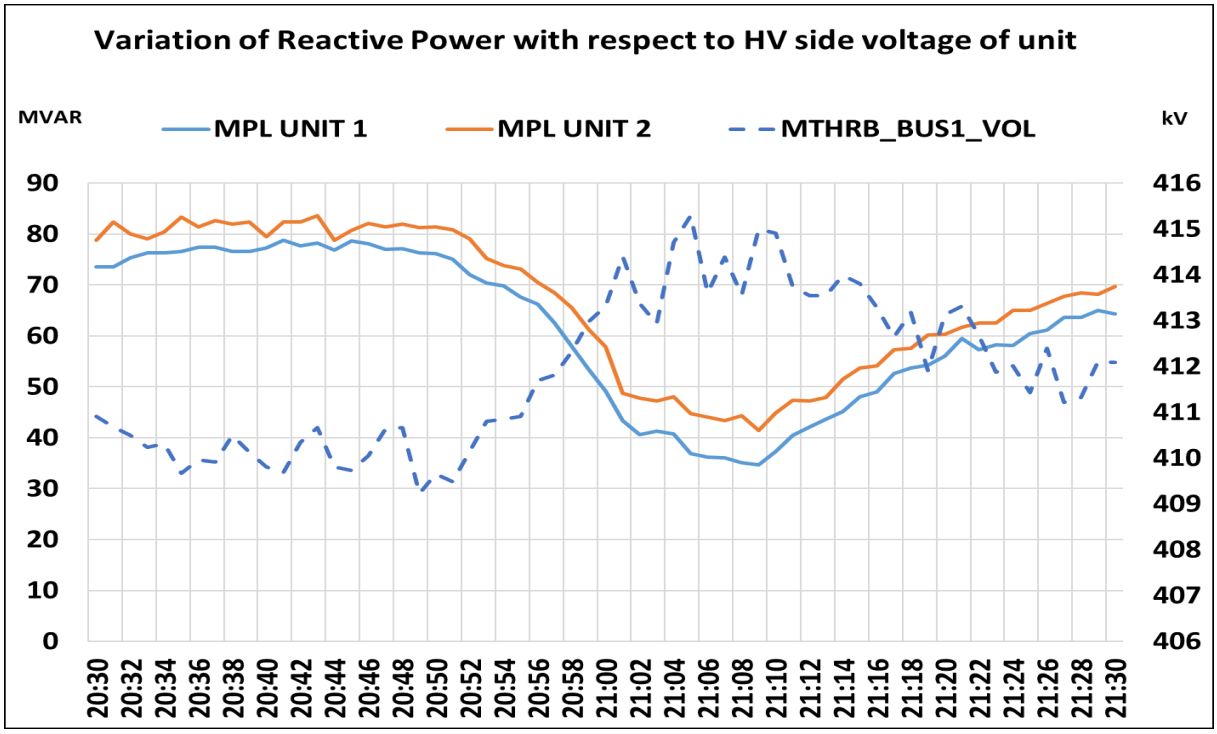
21:30


Variation of Reactive Power with respect to HV side voltage of unit
MVAR
APNRL UNIT 1
APNRL UNIT 2
APNRL_BUS1_VOL
kV
20
10
0
-10
-20
-30
-40
-50
-60
422
420
418
416
414
412
410
408
406
404
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of unit
MVAR
BARH UNIT 4
BARH UNIT 5
BARH_BUS1_VOL
kV
160
140
120
100
80
60
40
20
0
-20
-40
-60
416
414
412
410
408
406
404
402
400
398
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of unit
MVAR
DIKCHU UNIT 1
DIKCHU UNIT 2
DKCHU_BUS2_VOL
kV
8
6
4
2
0
-2
-4
-6
-8
131.5
131
130.5
130
129.5
129
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of unit
MVAR
JITPL UNIT 1
JITPL UNIT 2
JITPL_BUS1_VOL
kV
250
200
150
100
50
0
403
402
401
400
399
398
397
396
395
394
393
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of unit
MVAR
MPL UNIT 1
MPL UNIT 2
MTHRB_BUS1_VOL
kV
90
80
70
60
50
40
30
20
10
0
416
415
414
413
412
411
410
409
408
407
406
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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21:22
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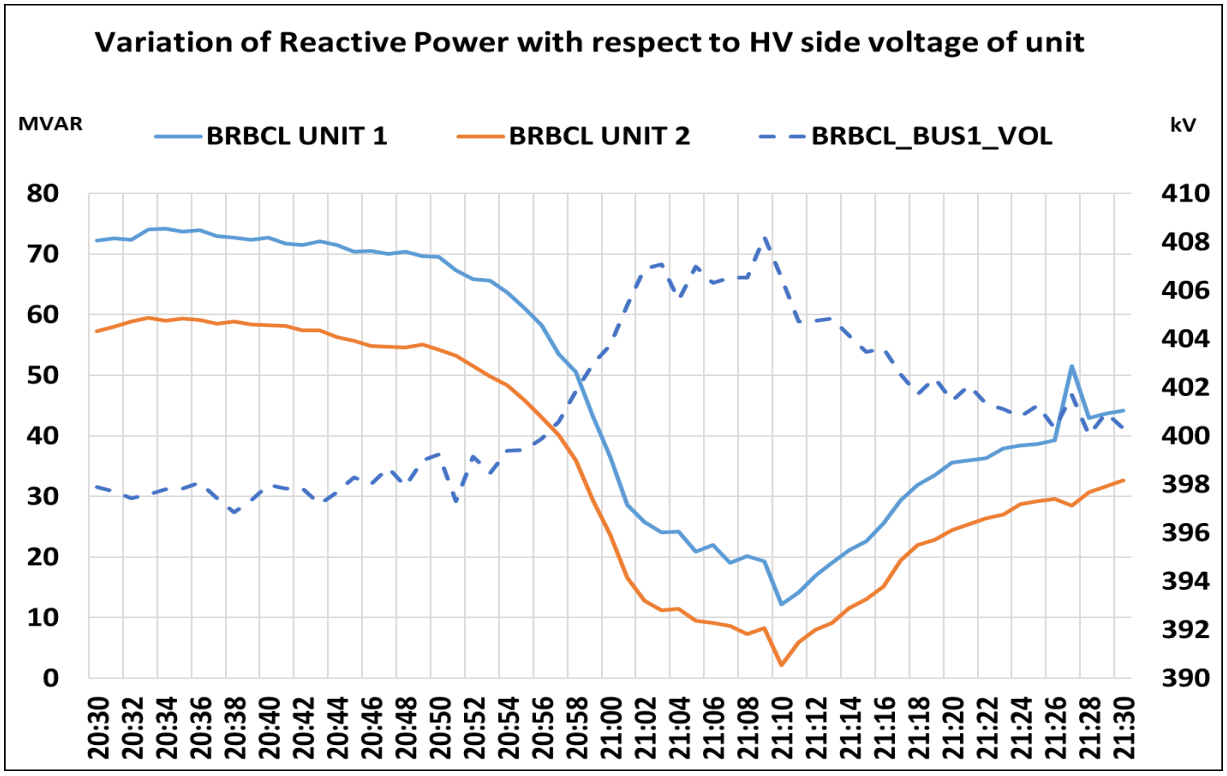
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of unit
MVAR
BRBCL UNIT 1
BRBCL UNIT 2
BRBCL_BUS1_VOL
kV
80
70
60
50
40
30
20
10
0
410
408
406
404
402
400
398
396
394
392
390
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
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21:22
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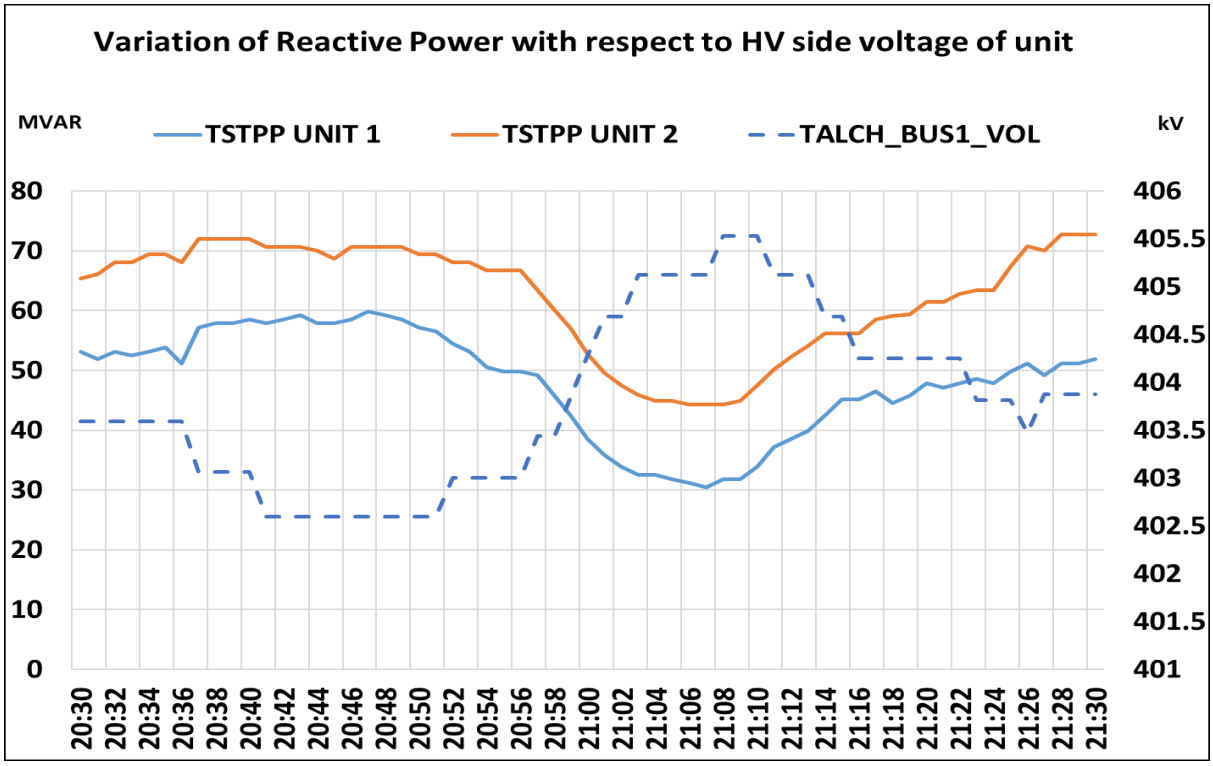
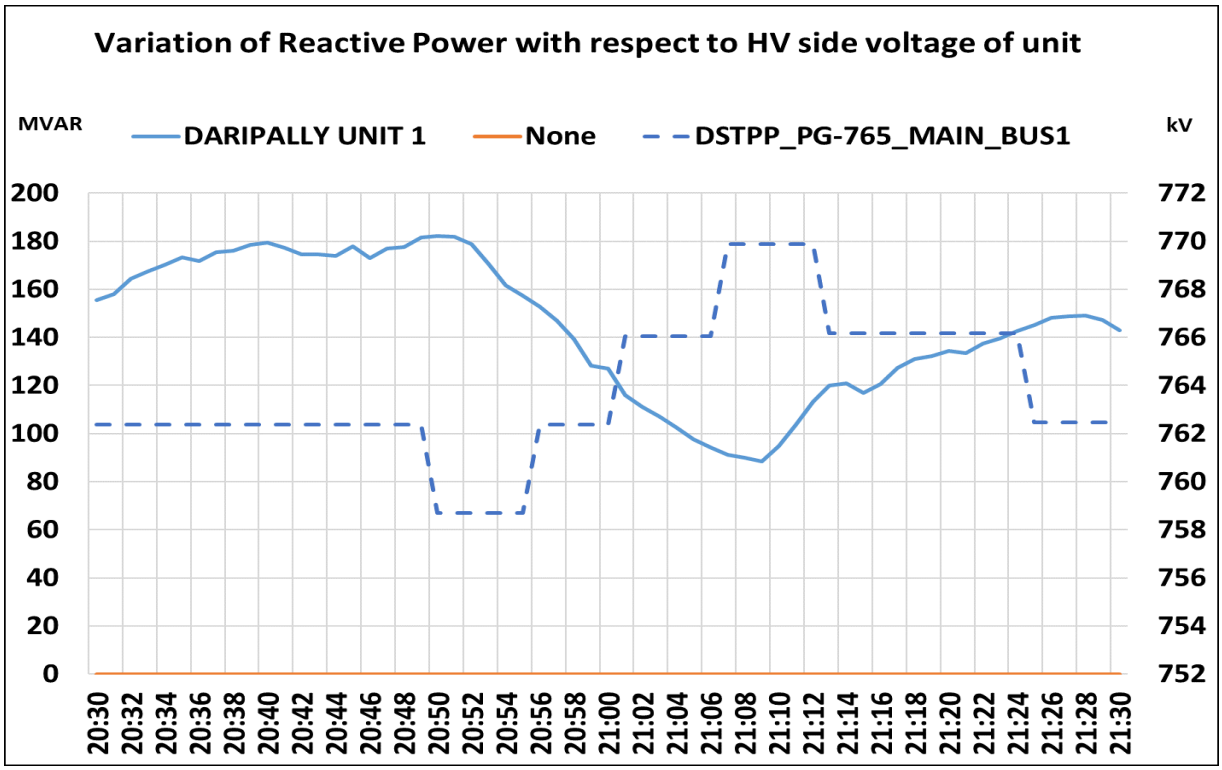
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of unit
MVAR
TSTPP UNIT 1
TSTPP UNIT 2
TALCH_BUS1_VOL
kV
80
70
60
50
40
30
20
10
0
406
405.5
405
404.5
404
403.5
403
402.5
402
401.5
401
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of unit
MVAR
DARIPALLY UNIT 1
None
DSTPP_PG-765_MAIN_BUS1
kV
200
180
160
140
120
100
80
60
40
20
0
772
770
768
766
764
762
760
758
756
754
752
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
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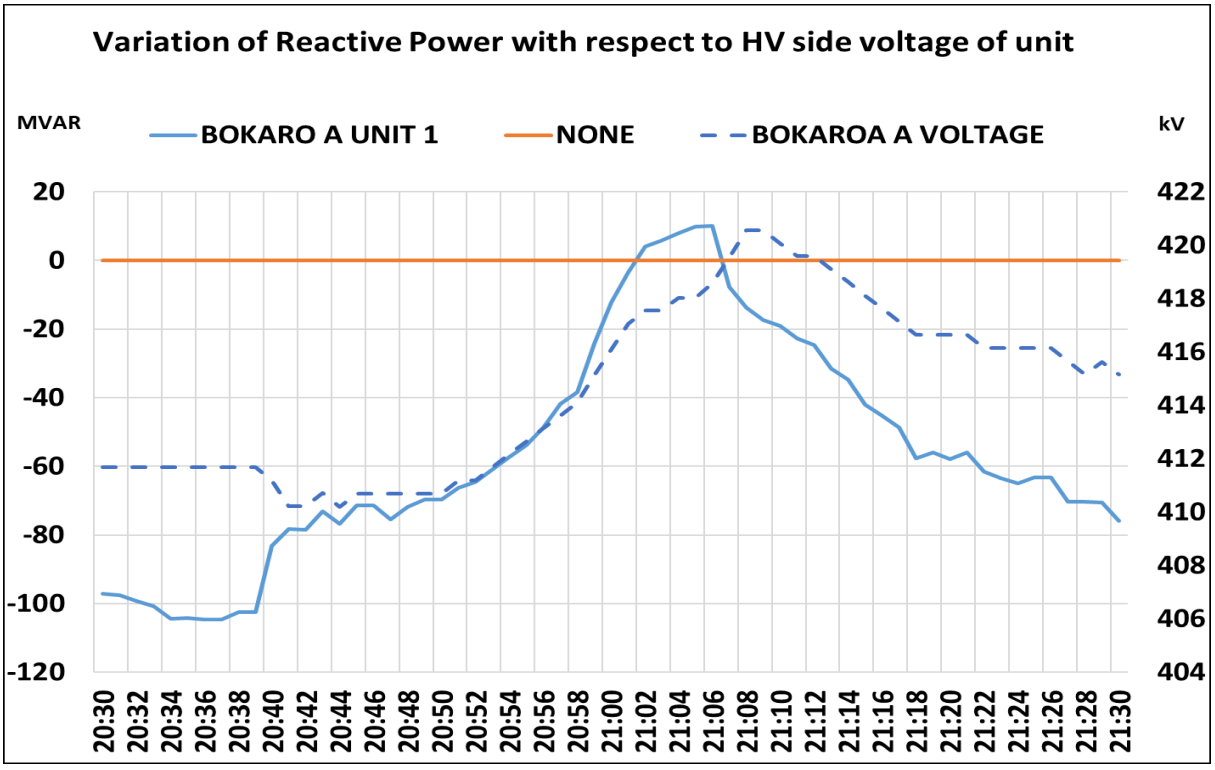
Variation of Reactive Power with respect to HV side voltage of unit
MVAR
BOKARO A UNIT 1
NONE
BOKAROA A VOLTAGE
kV
20
0
-20
-40
-60
-80
-100
-120
422
420
418
416
414
412
410
408
406
404
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
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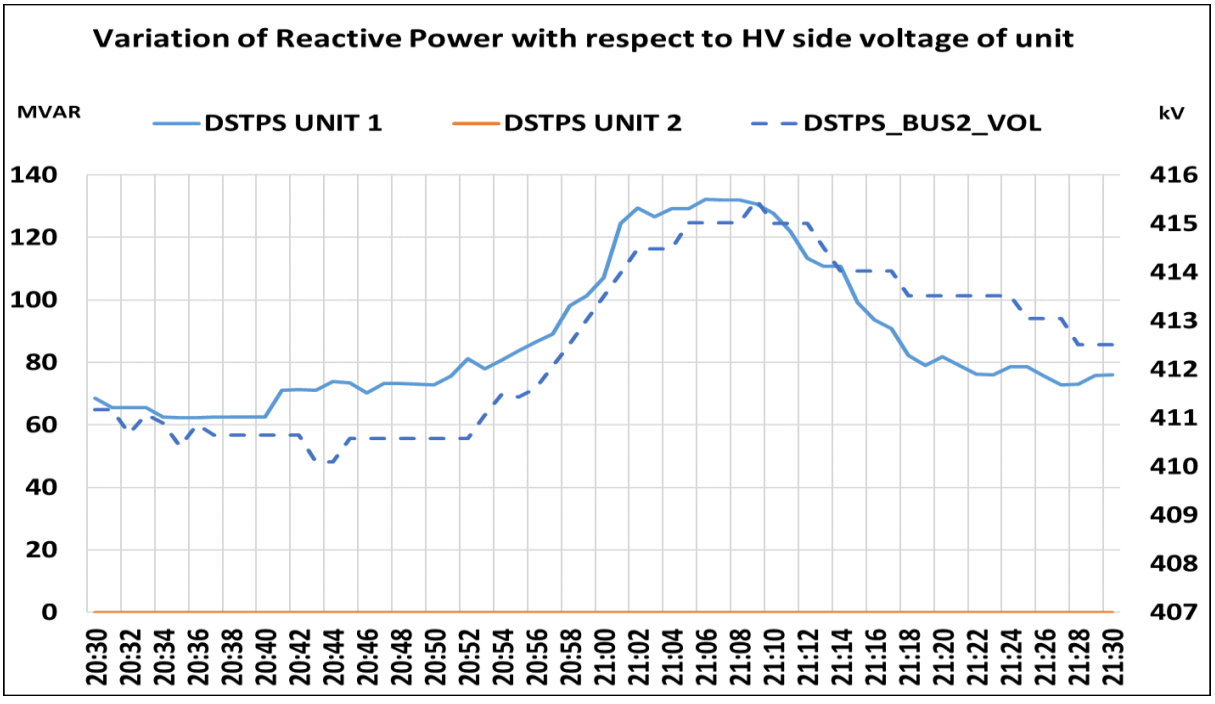
Variation of Reactive Power with respect to HV side voltage of unit
MVAR
DSTPS UNIT 1
DSTPS UNIT 2
DSTPS_BUS2_VOL
kV
140
120
100
80
60
40
20
0
416
415
414
413
412
411
410
409
408
407
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
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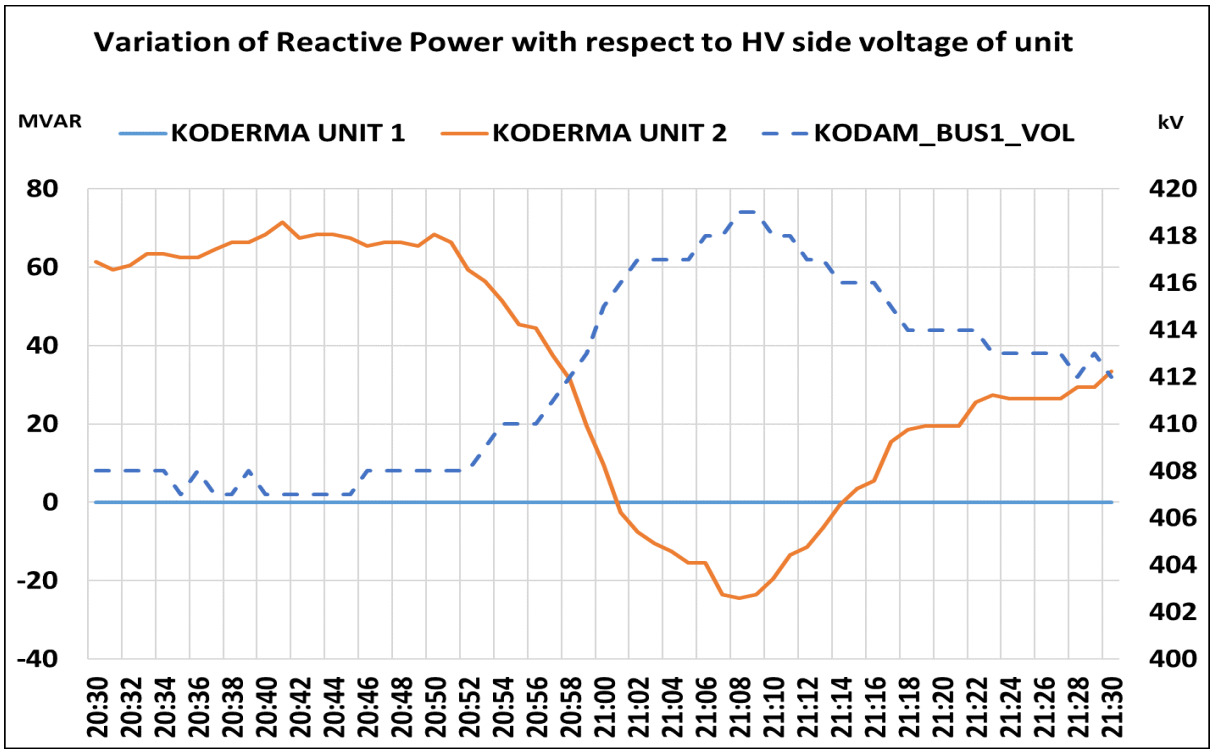
Variation of Reactive Power with respect to HV side voltage of unit
MVAR
KODERMA UNIT 1
KODERMA UNIT 2
KODAM_BUS1_VOL
kV
80
60
40
20
0
-20
-40
420
418
416
414
412
410
408
406
404
402
400
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
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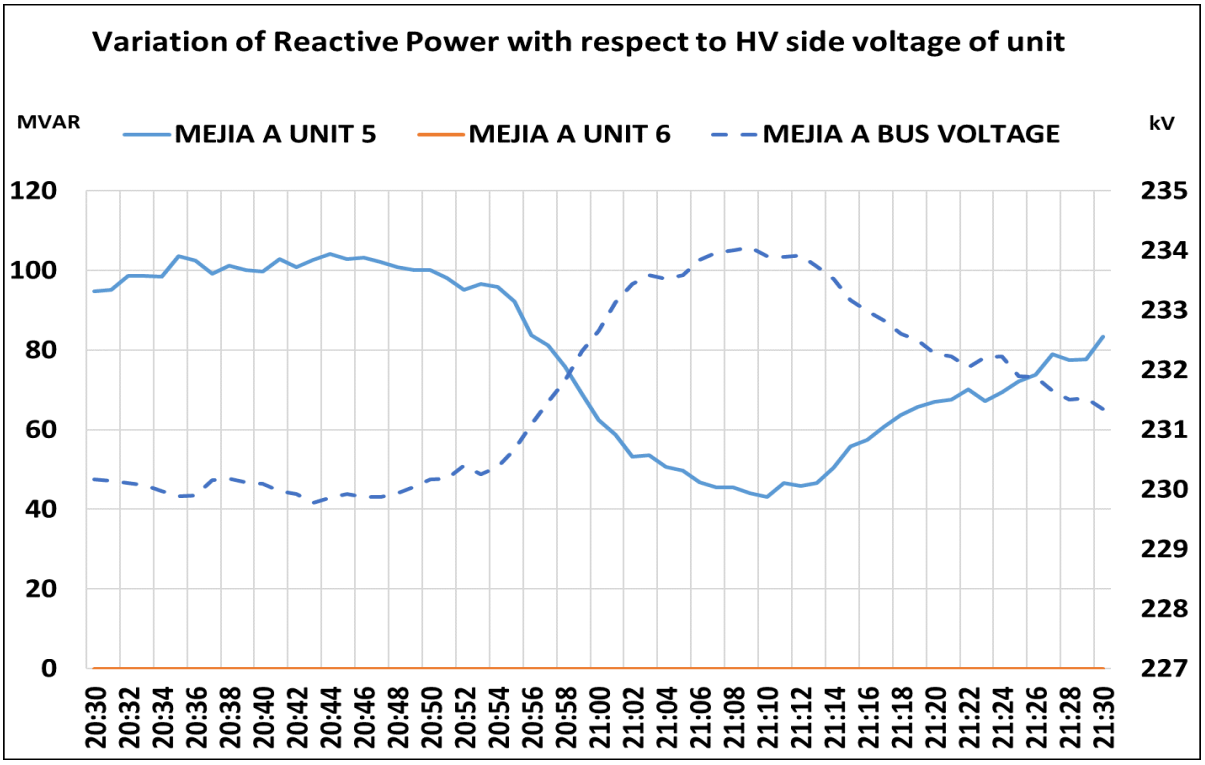
21:30


Variation of Reactive Power with respect to HV side voltage of unit
MVAR
MEJIA A UNIT 5
MEJIA A UNIT 6
MEJIA A BUS VOLTAGE
kV
120
100
80
60
40
20
0
235
234
233
232
231
230
229
228
227
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
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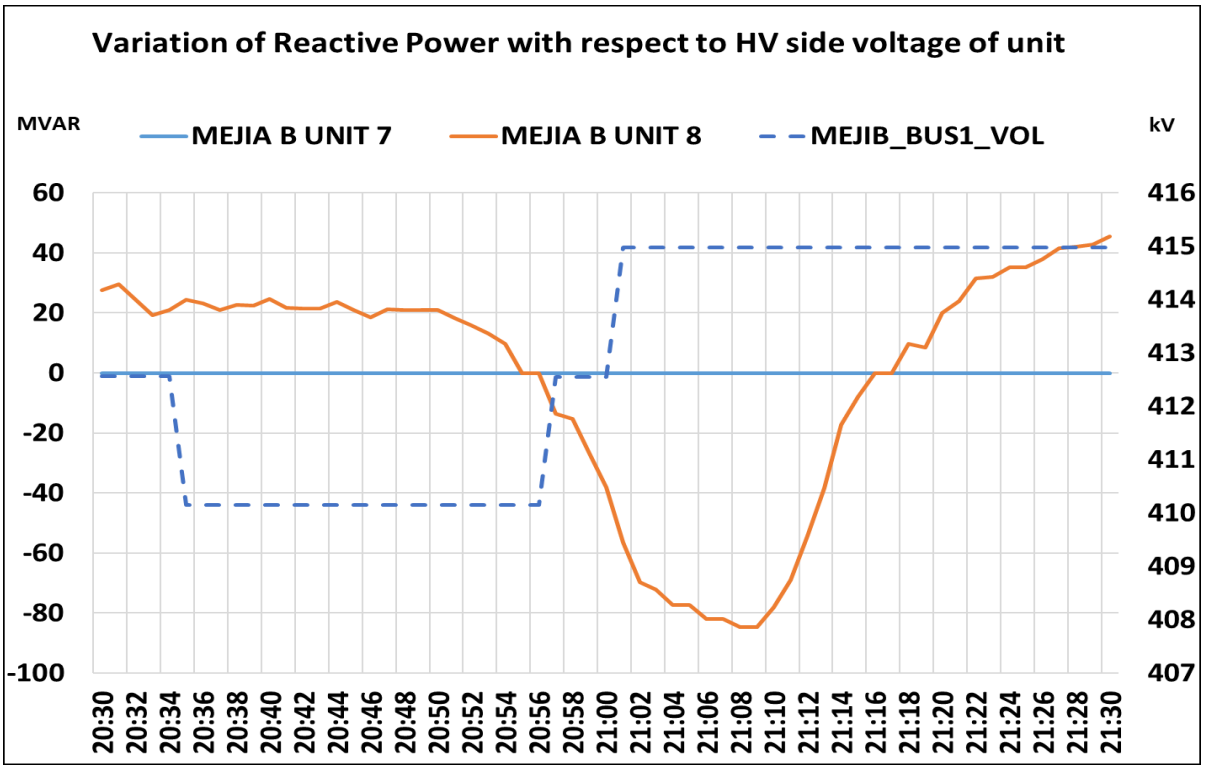
Variation of Reactive Power with respect to HV side voltage of unit
MVAR
MEJIA B UNIT 7
MEJIA B UNIT 8
MEJIB_BUS1_VOL
kV
60
40
20
0
-20
-40
-60
-80
-100
416
415
414
413
412
411
410
409
408
407
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
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20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
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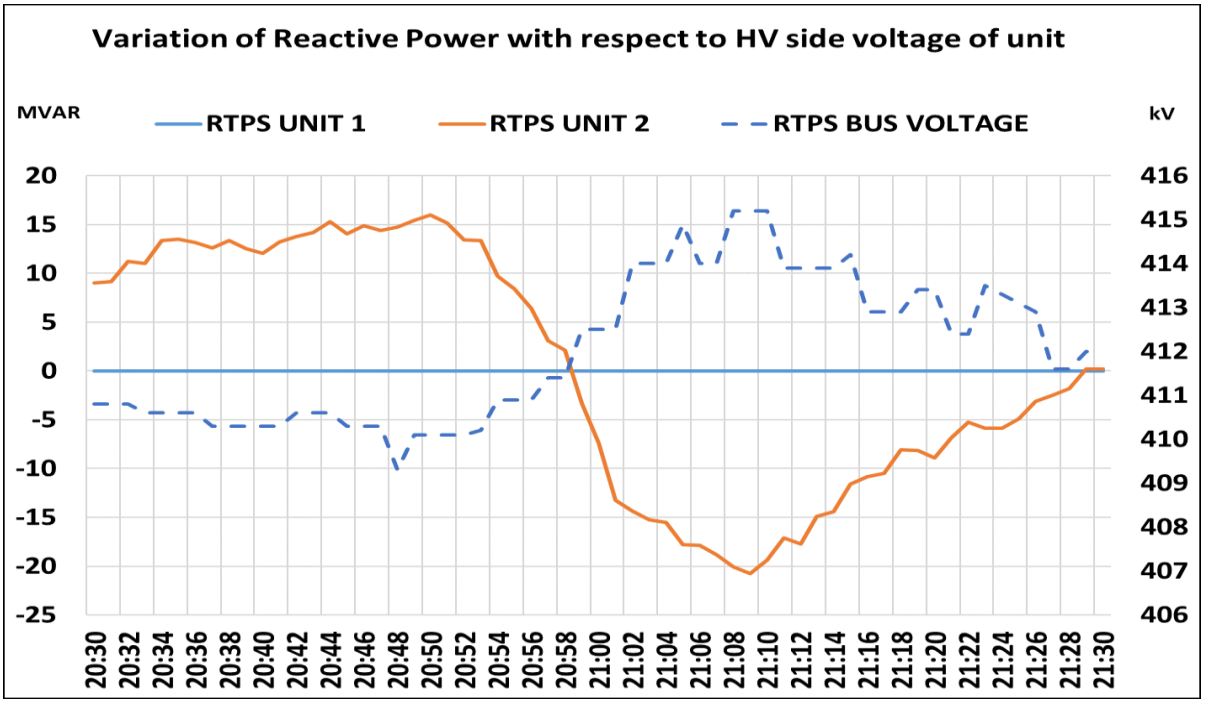
Variation of Reactive Power with respect to HV side voltage of unit
MVAR
RTPS UNIT 1
RTPS UNIT 2
RTPS BUS VOLTAGE
kV
20
15
10
5
0
-5
-10
-15
-20
-25
416
415
414
413
412
411
410
409
408
407
406
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
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21:22
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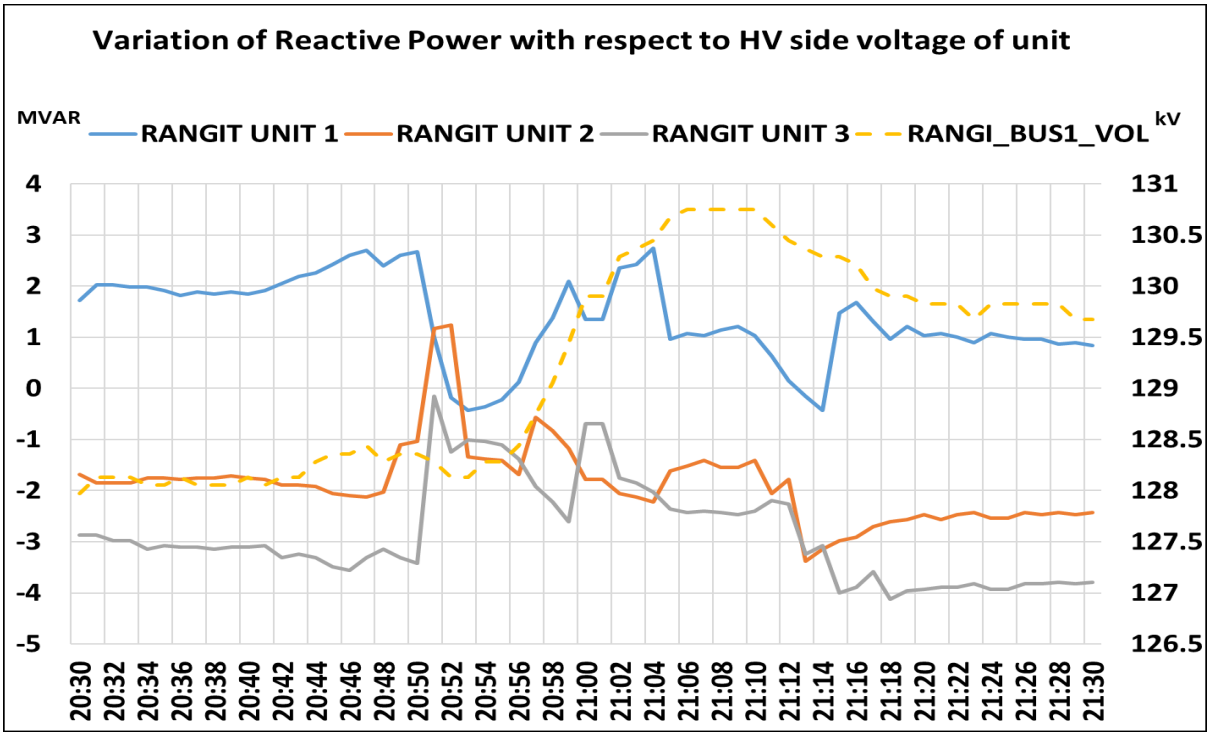
21:30


Variation of Reactive Power with respect to HV side voltage of unit
MVAR
RANGIT UNIT 1
RANGIT UNIT 2
RANGIT UNIT 3
RANGI_BUS1_VOL
kV
4
3
2
1
0
-1
-2
-3
-4
-5
131
130.5
130
129.5
129
128.5
128
127.5
127
126.5
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
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21:12
21:14
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21:22
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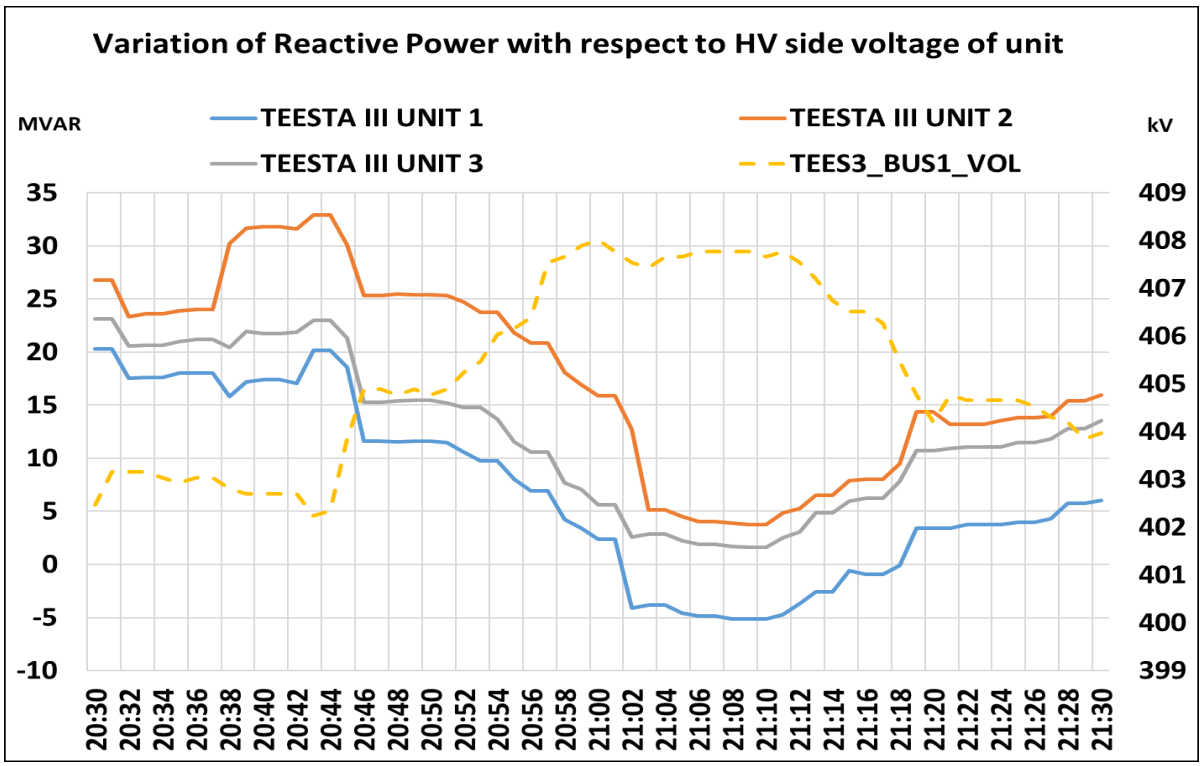
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of unit
MVAR
TEESTA III UNIT 1
TEESTA III UNIT 2
TEESTA III UNIT 3
TEES3_BUS1_VOL
kV
35
30
25
20
15
10
5
0
-5
-10
409
408
407
406
405
404
403
402
401
400
399
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
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21:14
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21:22
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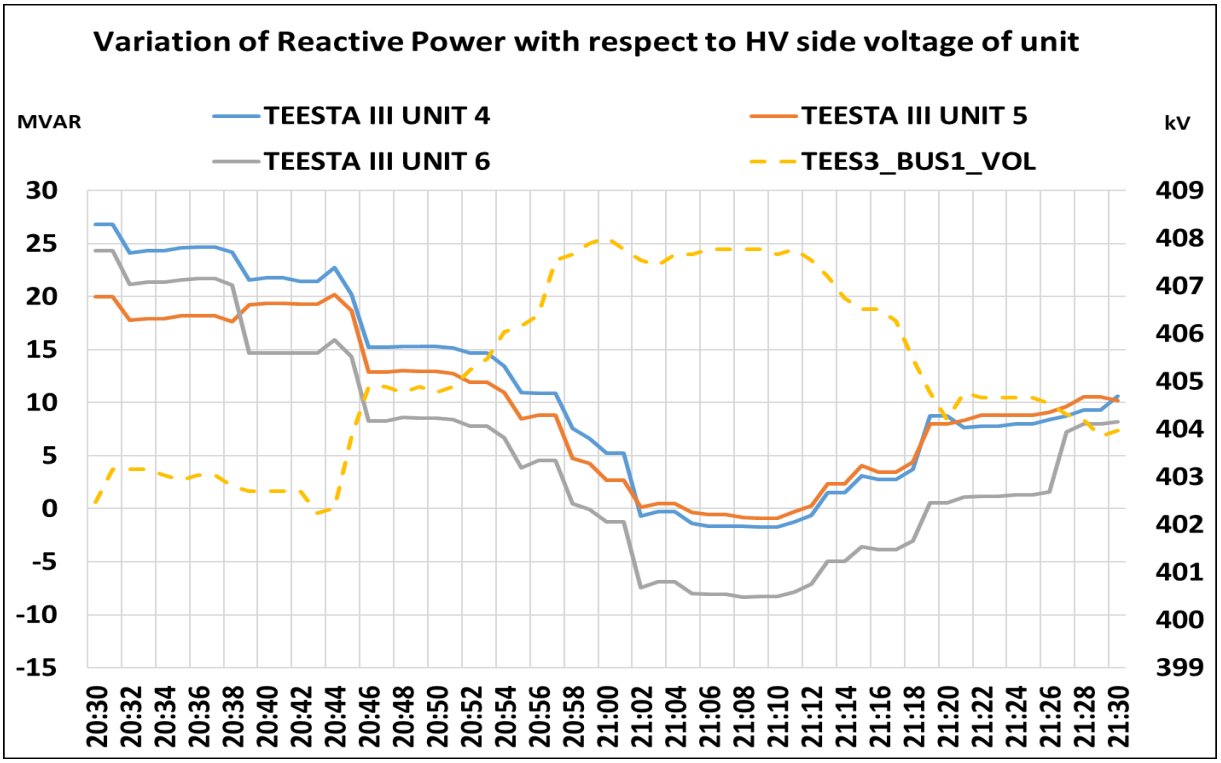
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of unit
MVAR
kV
TEESTA III UNIT 4
TEESTA III UNIT 5
TEESTA III UNIT 6
TEES3_BUS1_VOL
30
25
20
15
10
5
0
-5
-10
-15
409
408
407
406
405
404
403
402
401
400
399
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
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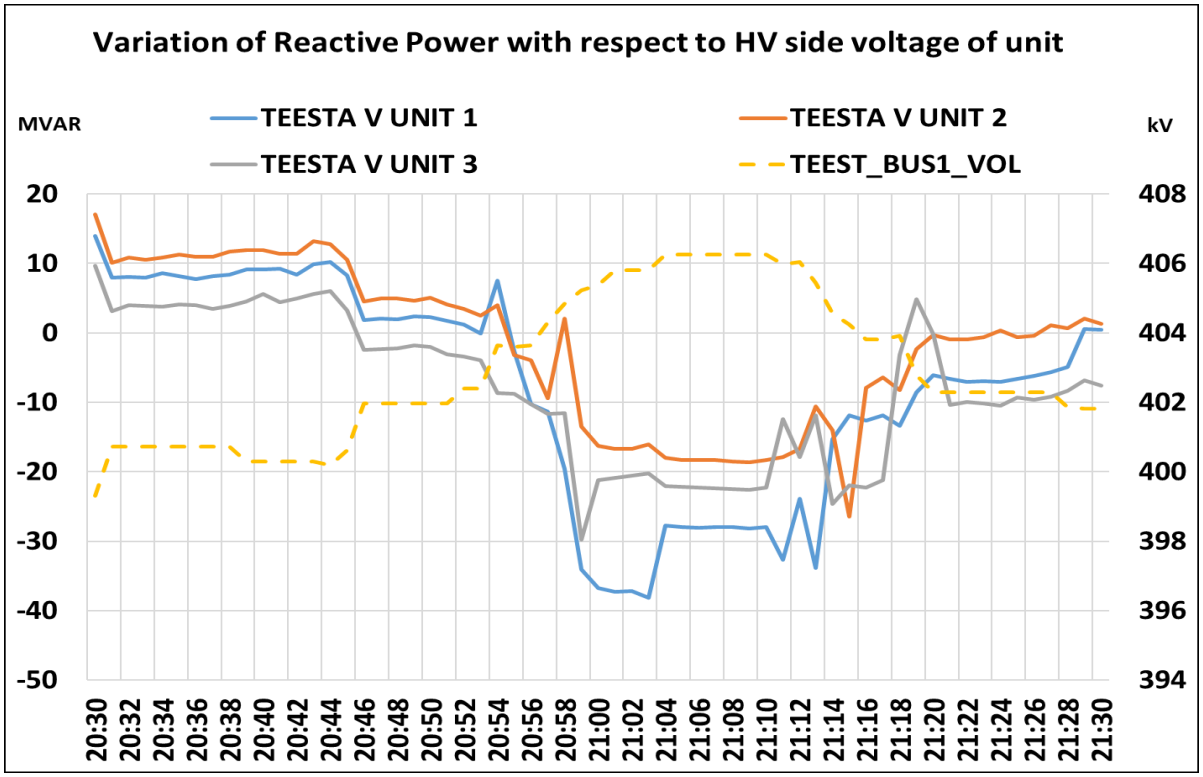
21:30


Variation of Reactive Power with respect to HV side voltage of unit
MVAR
kV
TEESTA V UNIT 1
TEESTA V UNIT 2
TEESTA V UNIT 3
TEEST_BUS1_VOL
20
10
0
-10
-20
-30
-40
-50
408
406
404
402
400
398
396
394
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
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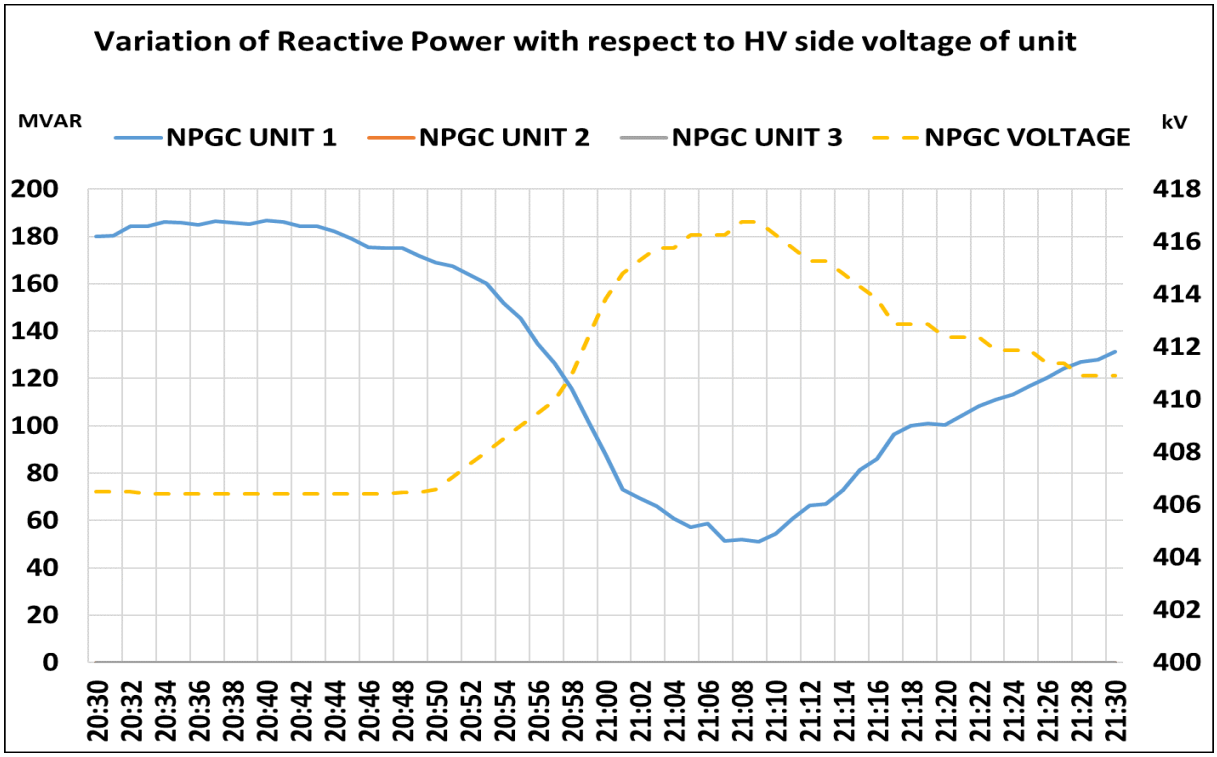
Variation of Reactive Power with respect to HV side voltage of unit
MVAR
NPGC UNIT 1
NPGC UNIT 2
NPGC UNIT 3
NPGC VOLTAGE
kV
200
180
160
140
120
100
80
60
40
20
0
418
416
414
412
410
408
406
404
402
400
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
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21:14
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21:18
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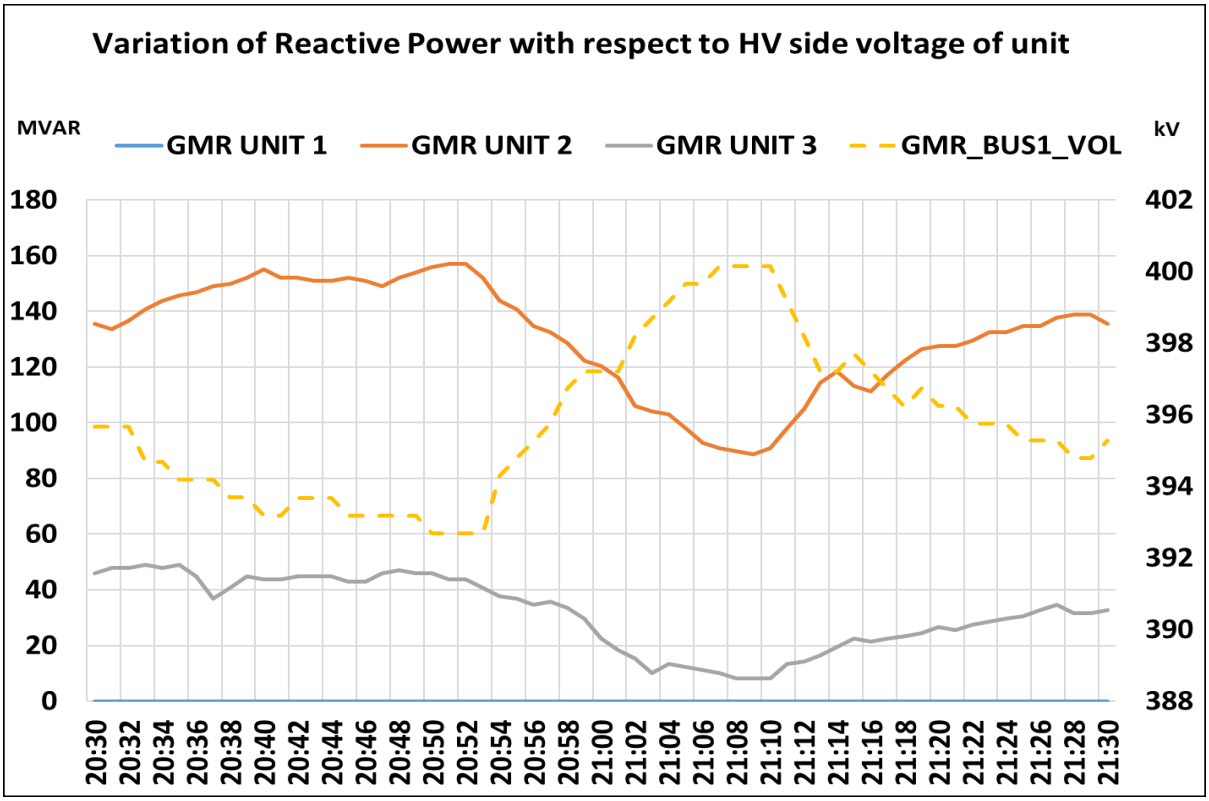
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of unit
MVAR
GMR UNIT 1
GMR UNIT 2
GMR UNIT 3
GMR_BUS1_VOL
kV
180
160
140
120
100
80
60
40
20
0
402
400
398
396
394
392
390
388
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
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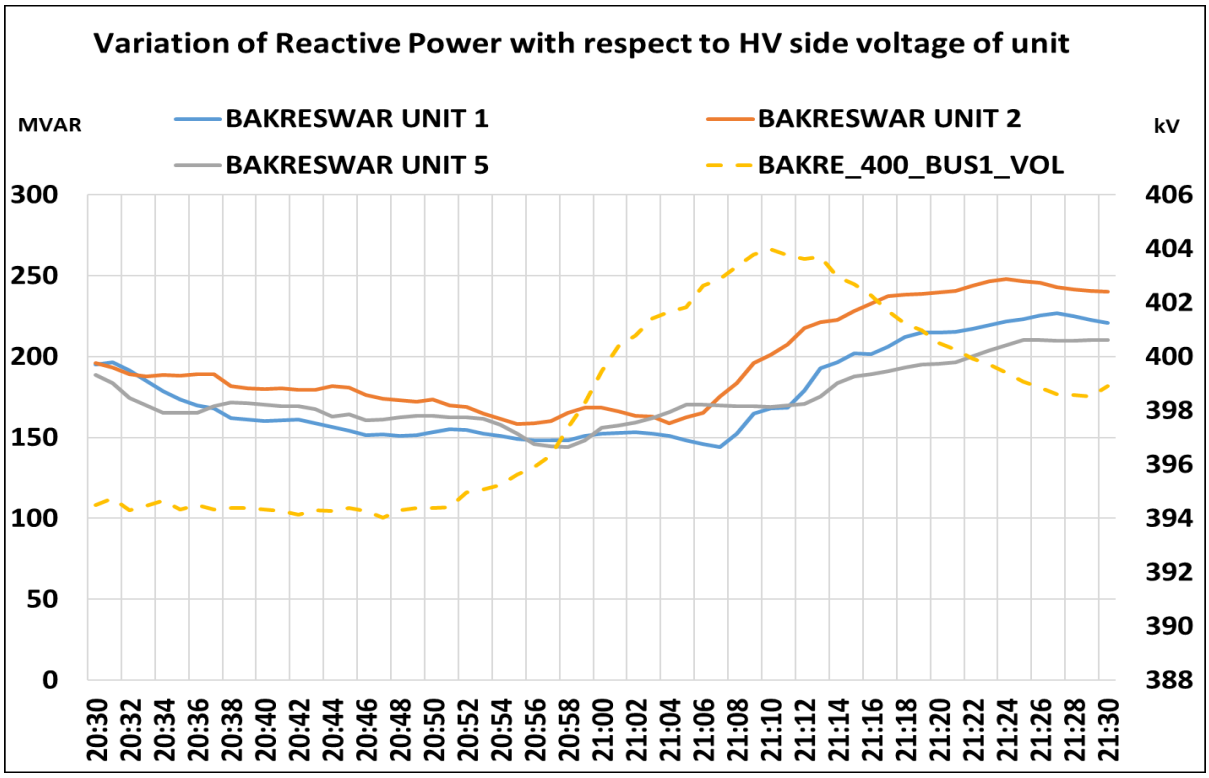
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of unit
MVAR
kV
BAKRESWAR UNIT 1
BAKRESWAR UNIT 2
BAKRESWAR UNIT 5
BAKRE_400_BUS1_VOL
300
250
200
150
100
50
0
406
404
402
400
398
396
394
392
390
388
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
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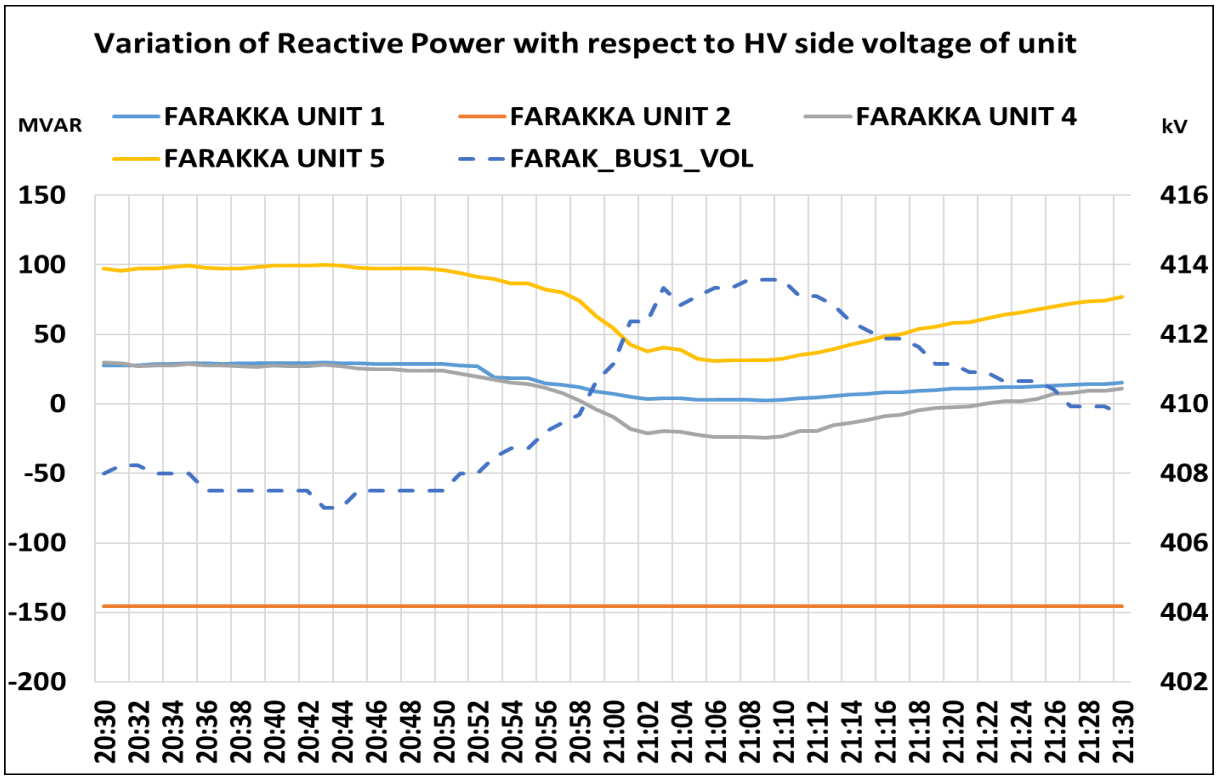
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of unit
MVAR
kV
FARAKKA UNIT 1
FARAKKA UNIT 2
FARAKKA UNIT 4
FARAKKA UNIT 5
FARAK_BUS1_VOL
150
100
50
0
-50
-100
-150
-200
416
414
412
410
408
406
404
402
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
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21:14
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21:18
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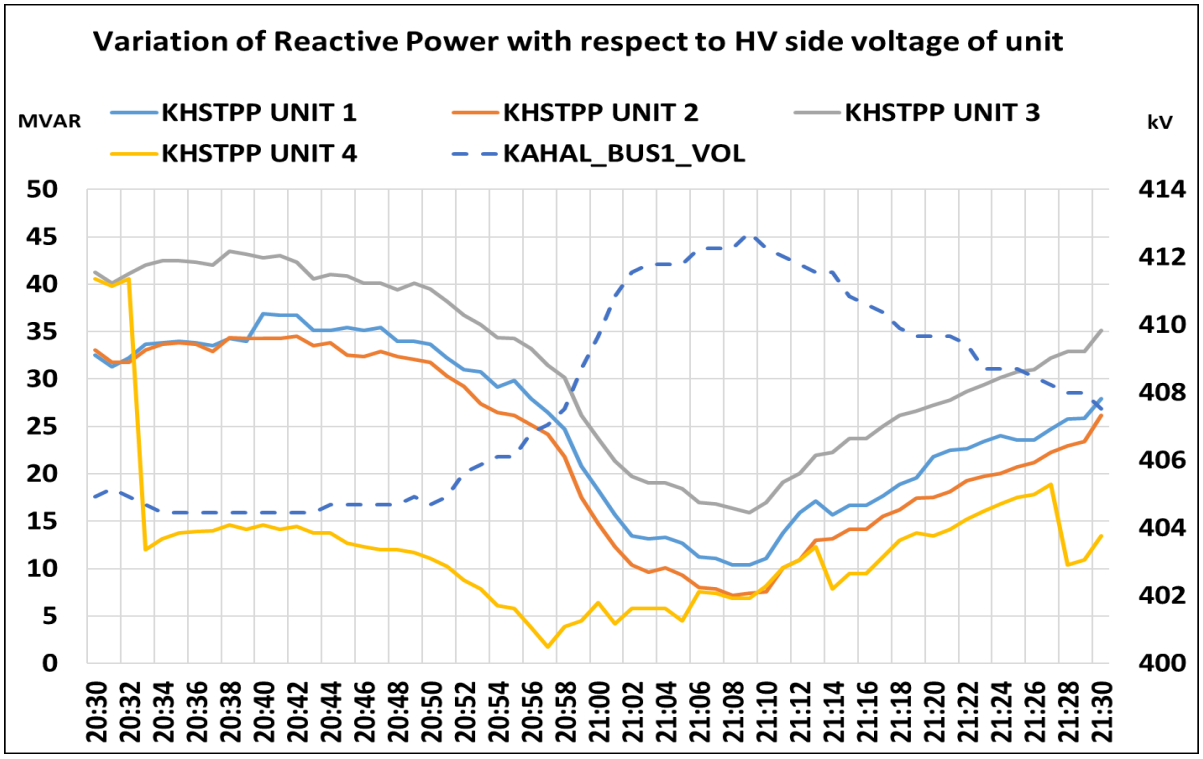
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of unit
MVAR
KHSTPP UNIT 1
KHSTPP UNIT 2
KHSTPP UNIT 3
KHSTPP UNIT 4
KAHAL_BUS1_VOL
kV
50
45
40
35
30
25
20
15
10
5
0
414
412
410
408
406
404
402
400
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
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21:14
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21:22
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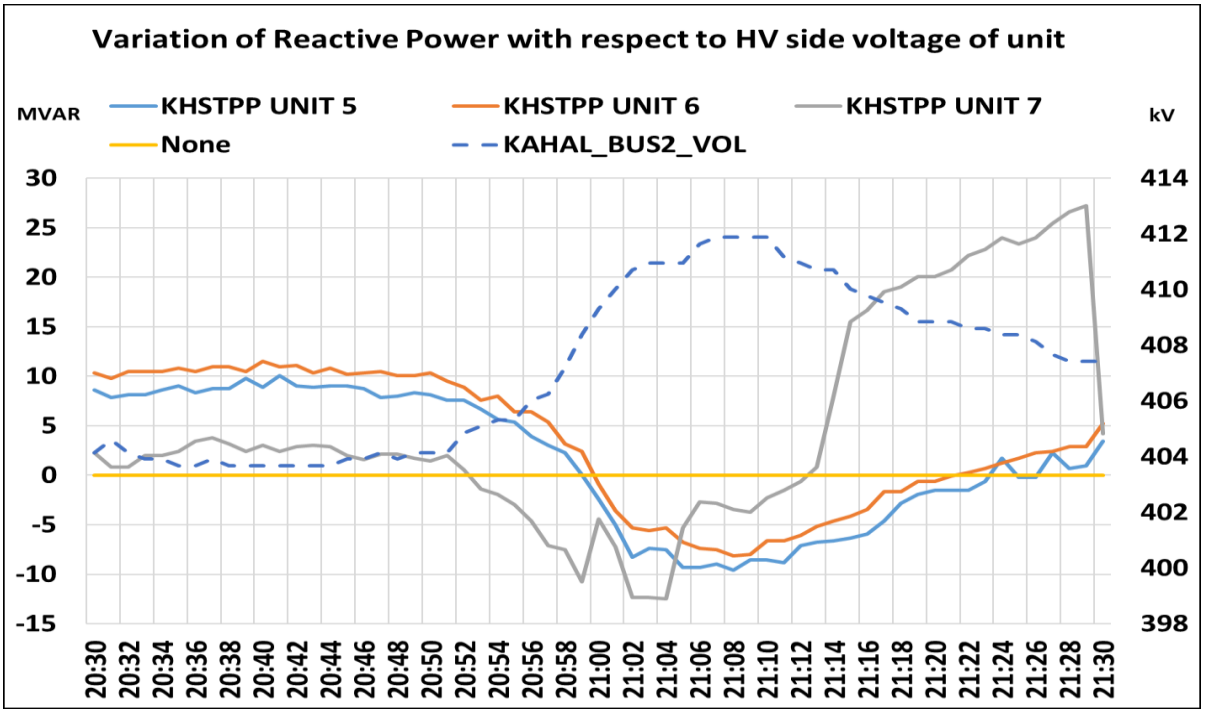
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of unit
MVAR
KHSTPP UNIT 5
KHSTPP UNIT 6
KHSTPP UNIT 7
None
KAHAL_BUS2_VOL
kV
30
25
20
15
10
5
0
-5
-10
-15
414
412
410
408
406
404
402
400
398
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
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21:22
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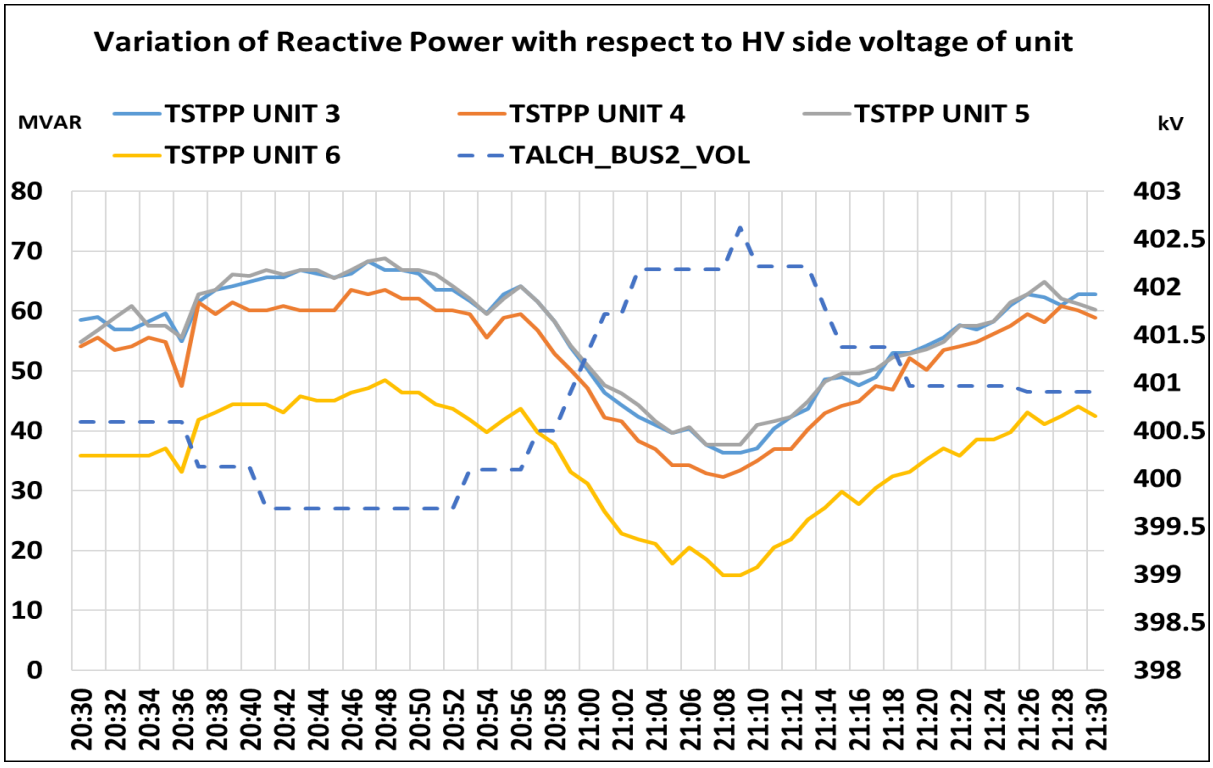
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of unit
MVAR
kV
TSTPP UNIT 3
TSTPP UNIT 4
TSTPP UNIT 5
TSTPP UNIT 6
TALCH_BUS2_VOL
80
70
60
50
40
30
20
10
0
403
402.5
402
401.5
401
400.5
400
399.5
399
398.5
398
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
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21:22
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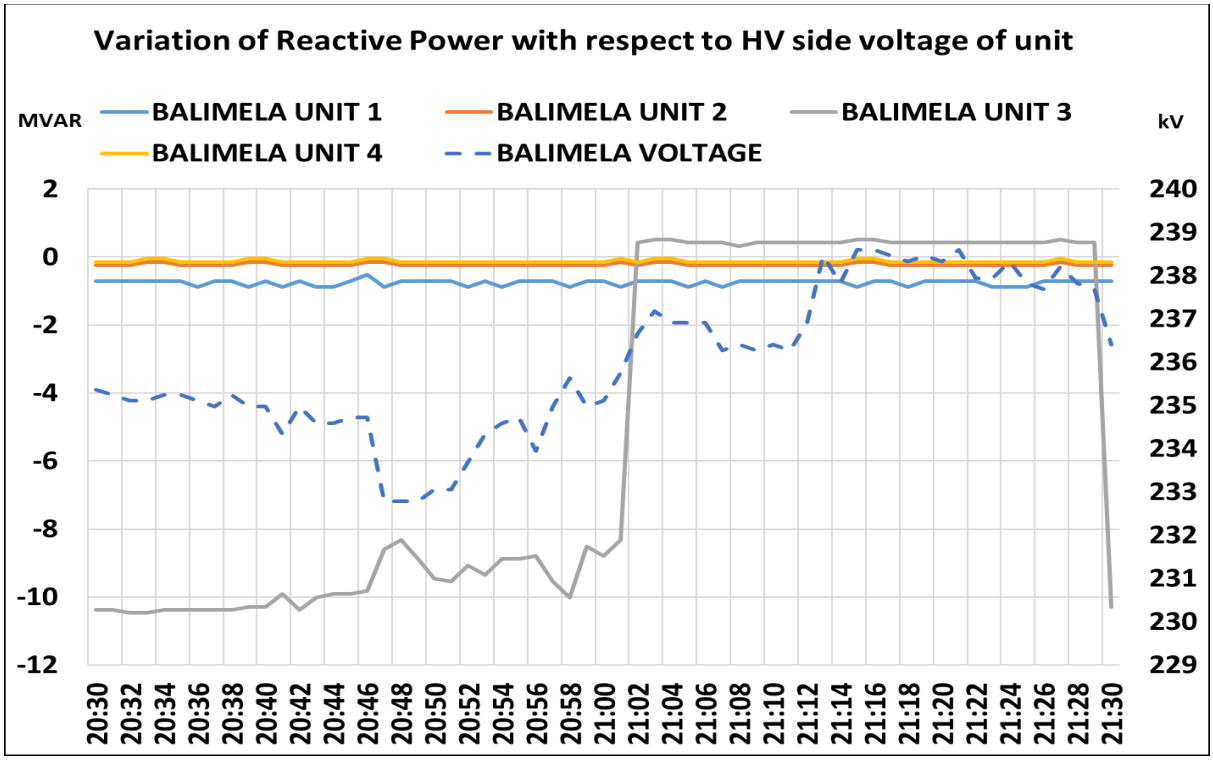
21:30


Variation of Reactive Power with respect to HV side voltage of unit
MVAR
kV
BALIMELA UNIT 1
BALIMELA UNIT 2
BALIMELA UNIT 3
BALIMELA UNIT 4
BALIMELA VOLTAGE
2
0
-2
-4
-6
-8
-10
-12
240
239
238
237
236
235
234
233
232
231
230
229
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
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21:02
21:04
21:06
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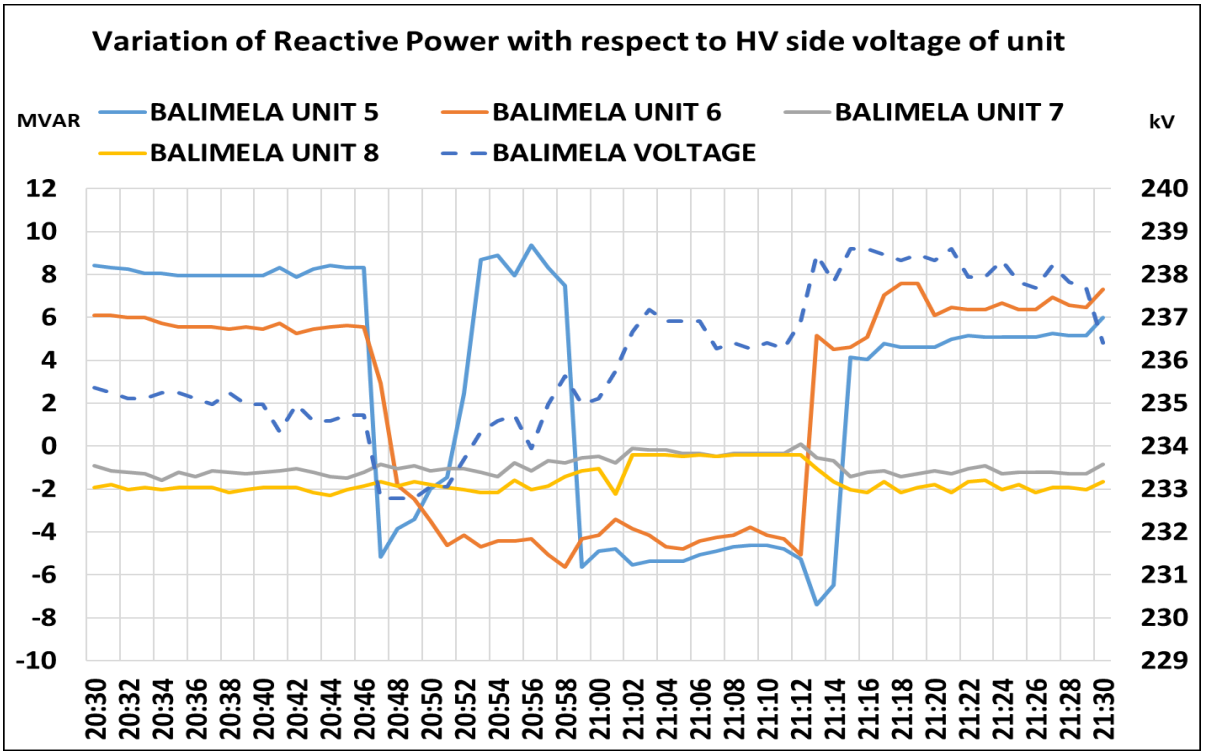
Variation of Reactive Power with respect to HV side voltage of unit
MVAR
kV
BALIMELA UNIT 5
BALIMELA UNIT 6
BALIMELA UNIT 7
BALIMELA UNIT 8
BALIMELA VOLTAGE
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
240
239
238
237
236
235
234
233
232
231
230
229
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
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21:18
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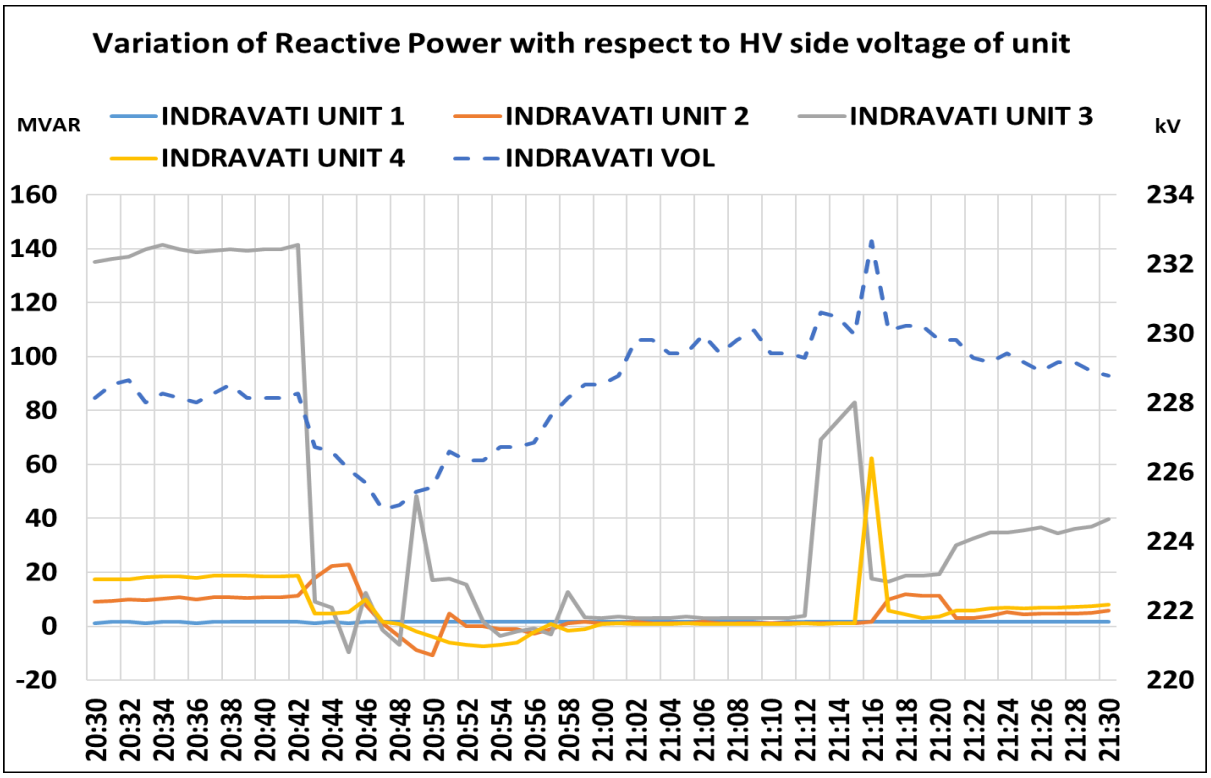
Variation of Reactive Power with respect to HV side voltage of unit
MVAR
kV
INDRAVATI UNIT 1
INDRAVATI UNIT 2
INDRAVATI UNIT 3
INDRAVATI UNIT 4
INDRAVATI VOL
160
140
120
100
80
60
40
20
0
-20
234
232
230
228
226
224
222
220
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
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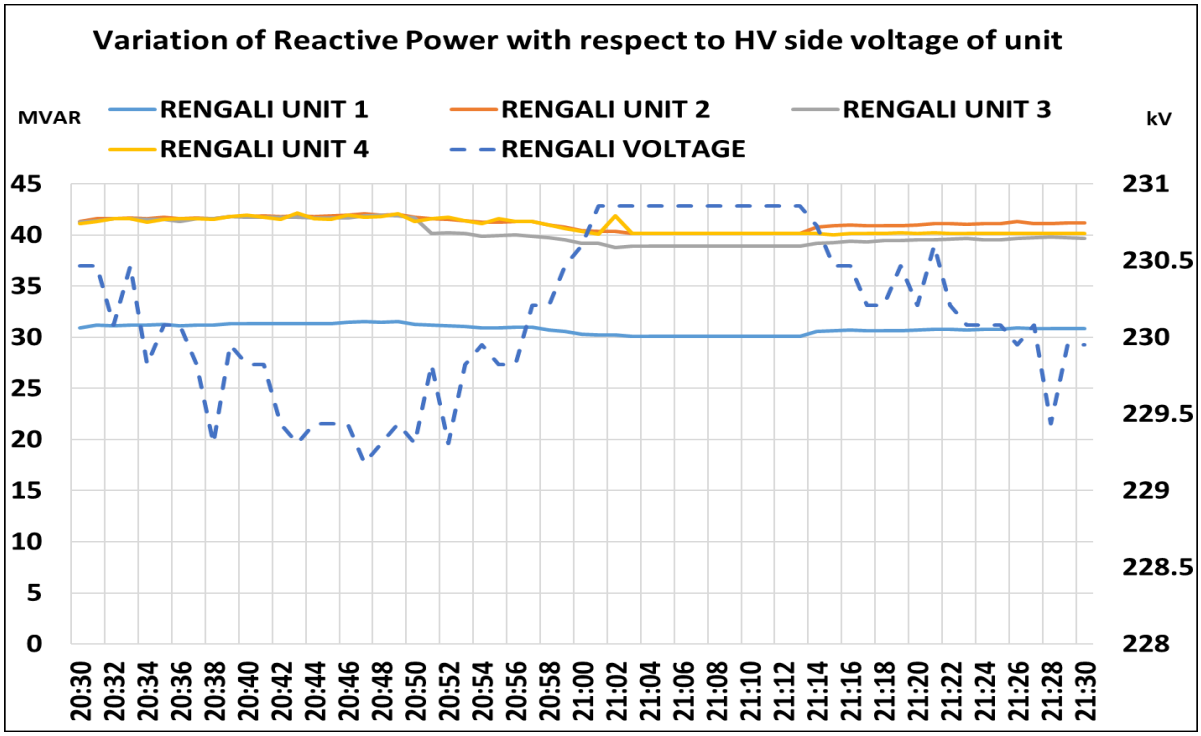
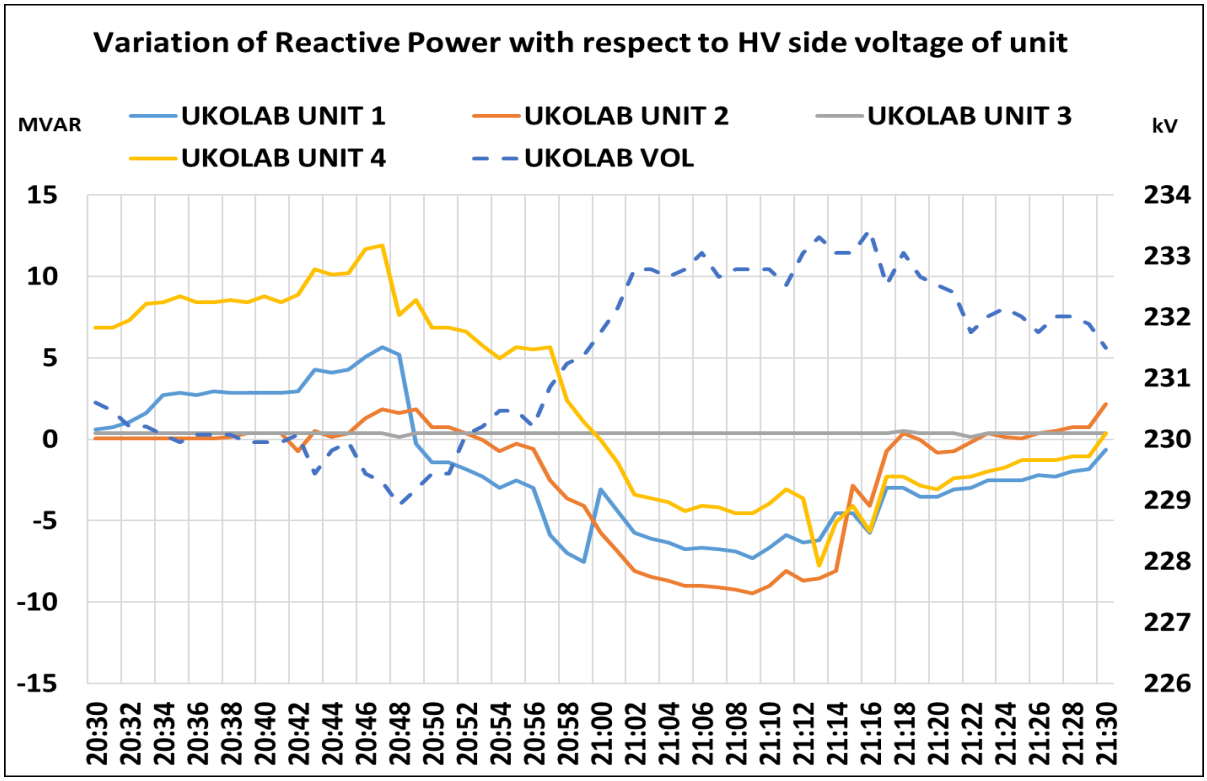
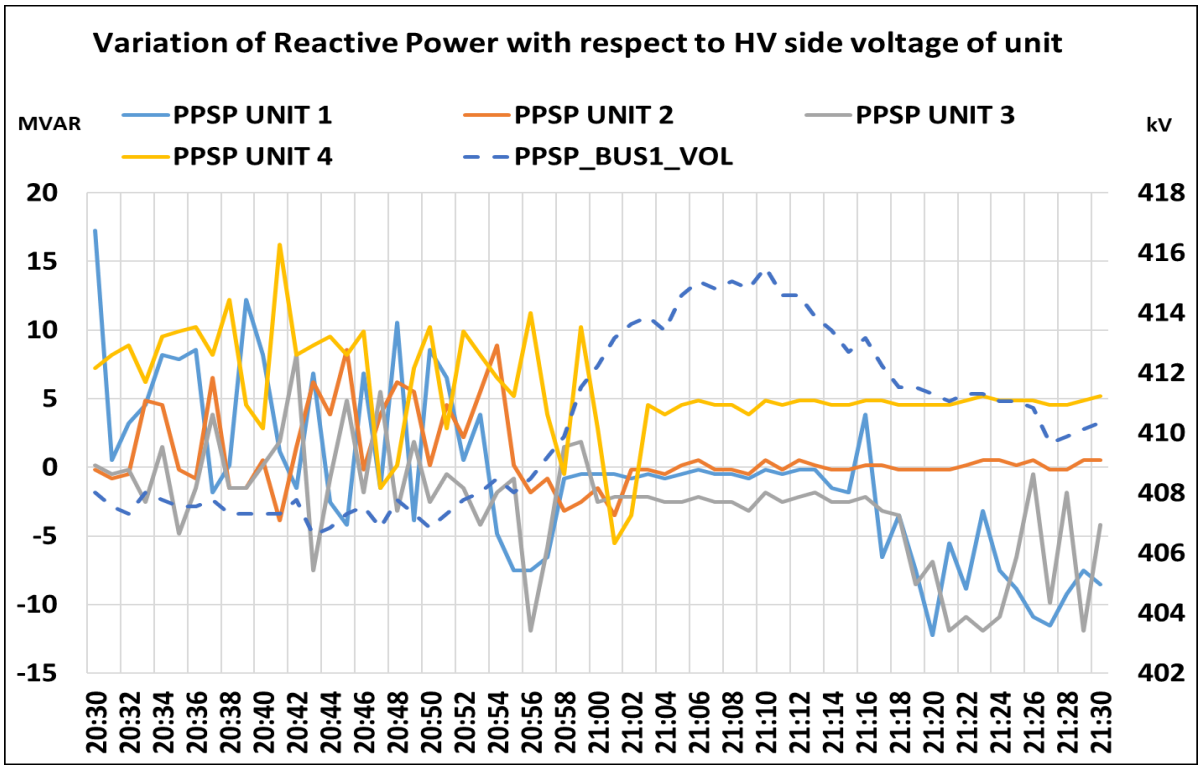
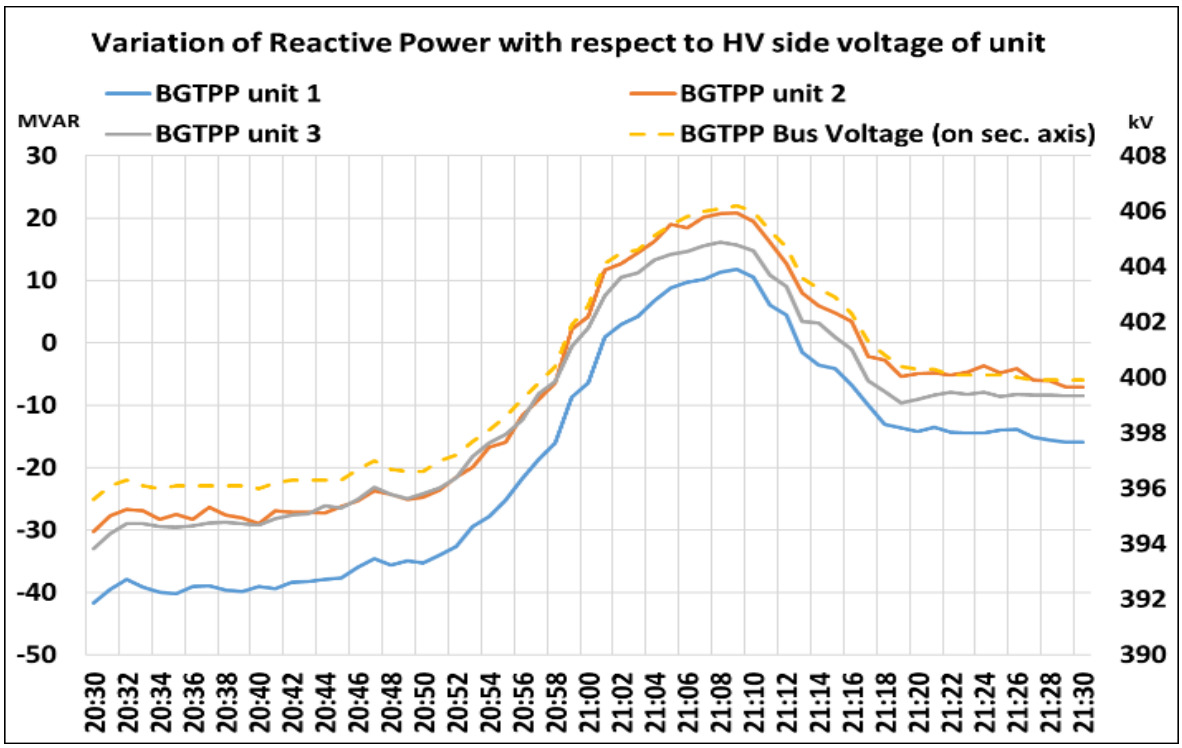
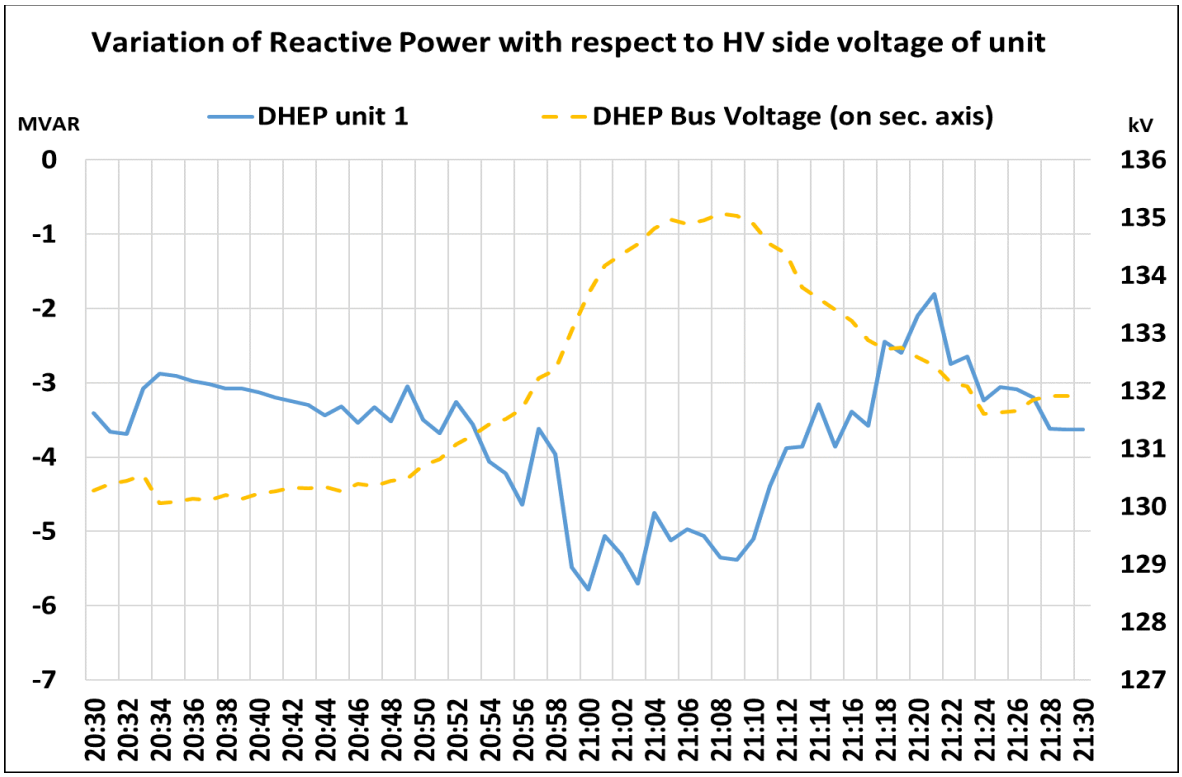
21:30

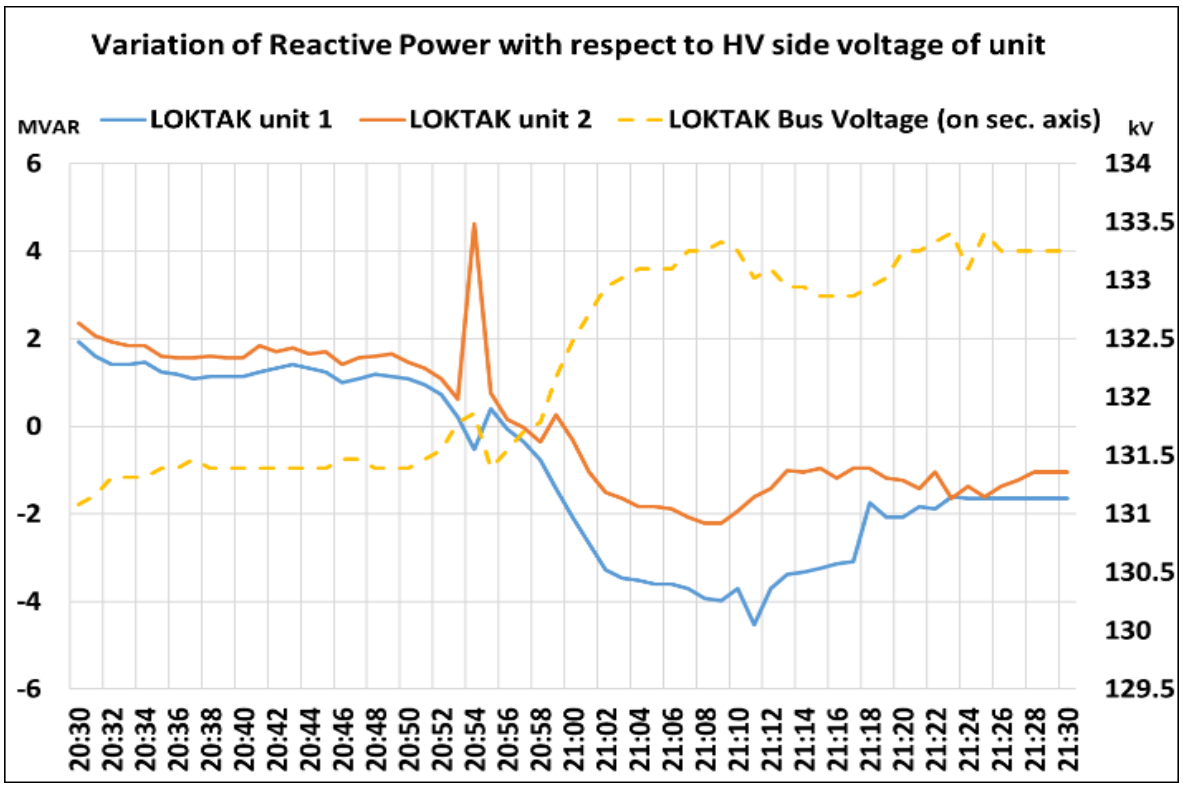

Variation of Reactive Power with respect to HV side voltage of unit
MVAR
kV
RENGALI UNIT 1
RENGALI UNIT 2
RENGALI UNIT 3
RENGALI UNIT 4
RENGALI VOLTAGE
45
40
35
30
25
20
15
10
5
0
231
230.5
230
229.5
229
228.5
228
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

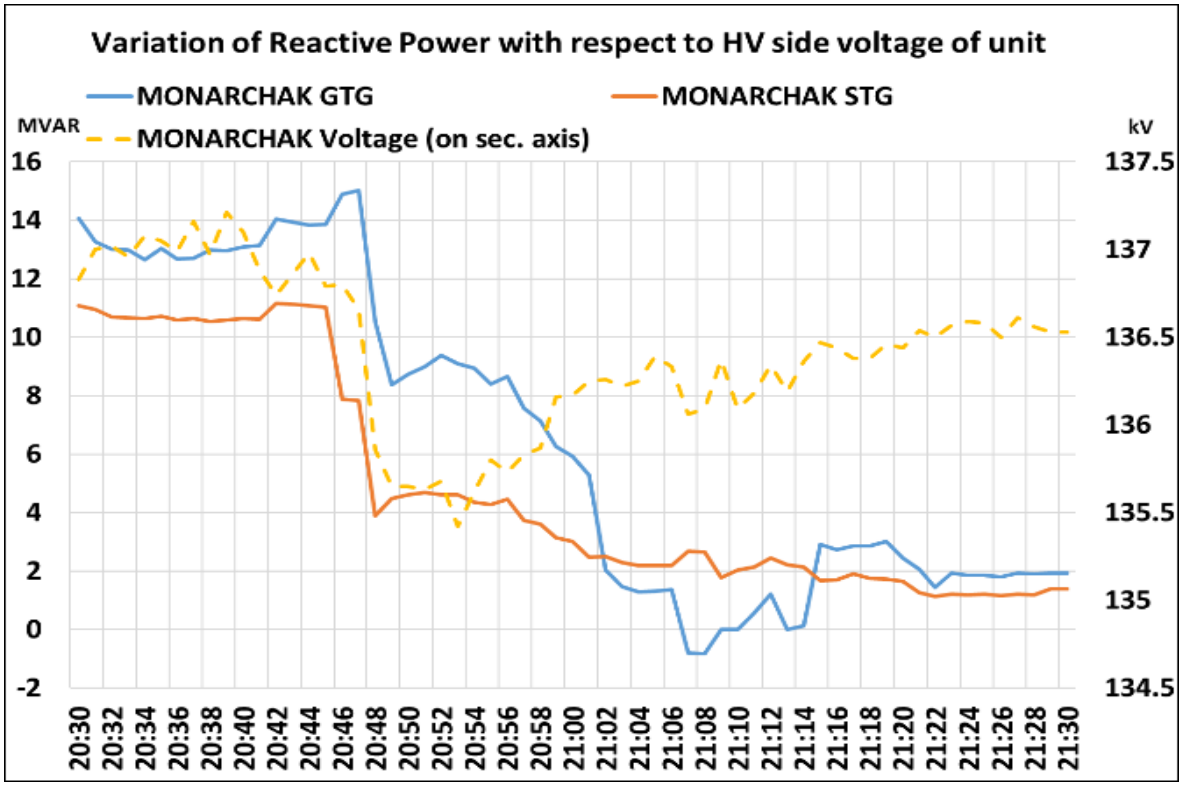

Variation of Reactive Power with respect to HV side voltage of unit
MVAR
kV
UKOLAB UNIT 1
UKOLAB UNIT 2
UKOLAB UNIT 3
UKOLAB UNIT 4
UKOLAB VOL
15
10
5
0
-5
-10
-15
234
233
232
231
230
229
228
227
226
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

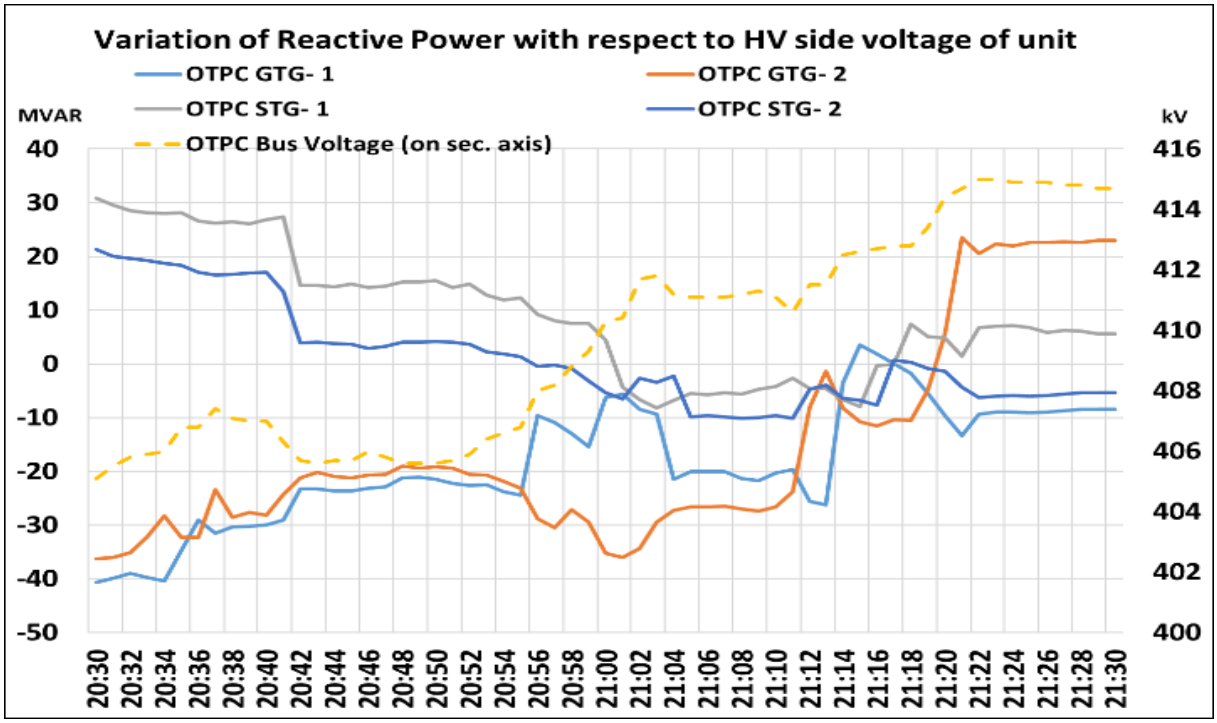

Variation of Reactive Power with respect to HV side voltage of unit
MVAR
kV
PPSP UNIT 1
PPSP UNIT 2
PPSP UNIT 3
PPSP UNIT 4
PPSP_BUS1_VOL
20
15
10
5
0
-5
-10
-15
418
416
414
412
410
408
406
404
402
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

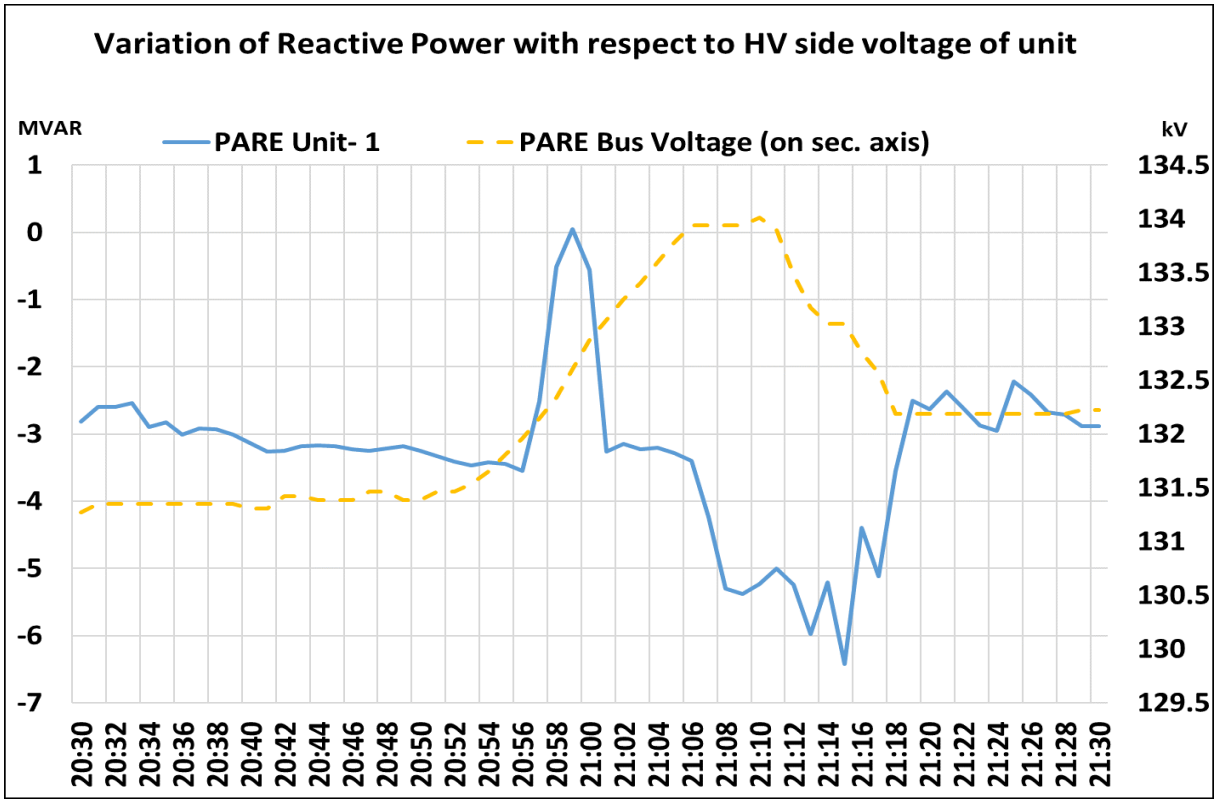

Variation of Reactive Power with respect to HV side voltage of unit
BGTPP unit 1
BGTPP unit 2
BGTPP unit 3
BGTPP Bus Voltage (on sec. axis)
MVAR
kV
30
20
10
0
-10
-20
-30
-40
-50
408
406
404
402
400
398
396
394
392
390
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

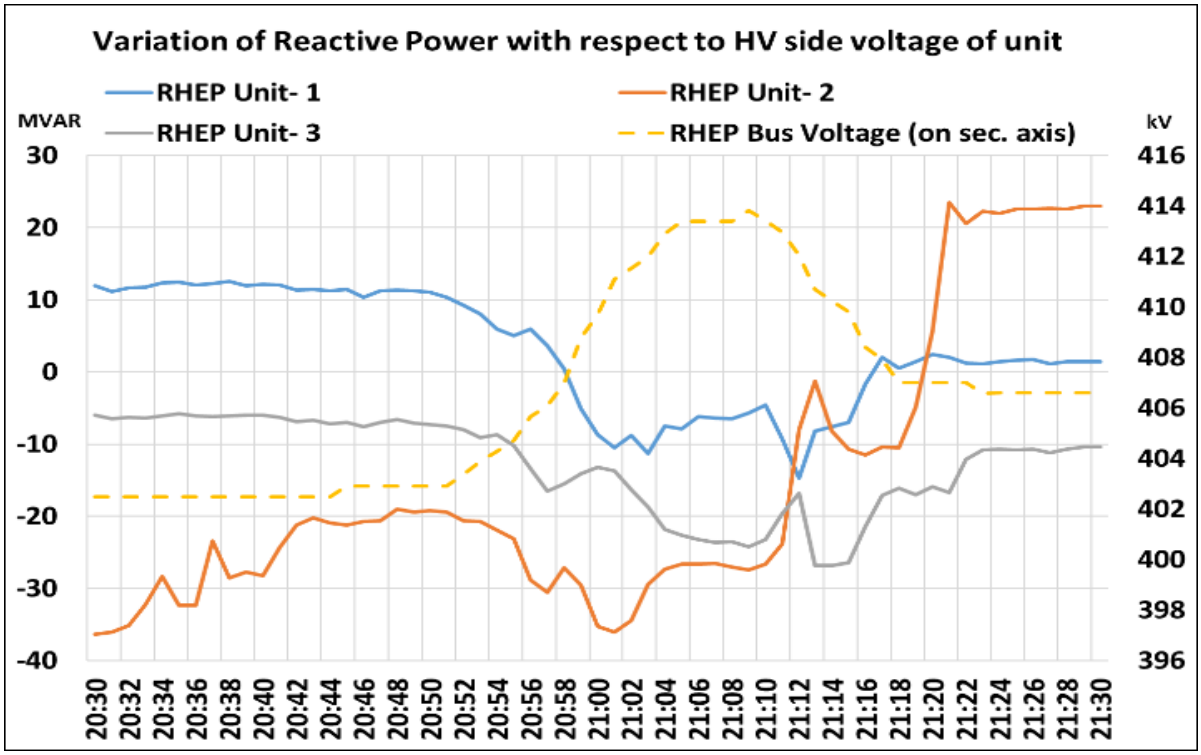

Variation of Reactive Power with respect to HV side voltage of unit
DHEP unit 1
DHEP Bus Voltage (on sec. axis)
MVAR
kV
0
-1
-2
-3
-4
-5
-6
-7
136
135
134
133
132
131
130
129
128
127
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Variation of Reactive Power with respect to HV side voltage of unit
MVAR
LOKTAK unit 1
LOKTAK unit 2
LOKTAK Bus Voltage (on sec. axis)
kV
6
4
2
0
-2
-4
-6
134
133.5
133
132.5
132
131.5
131
130.5
130
129.5
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

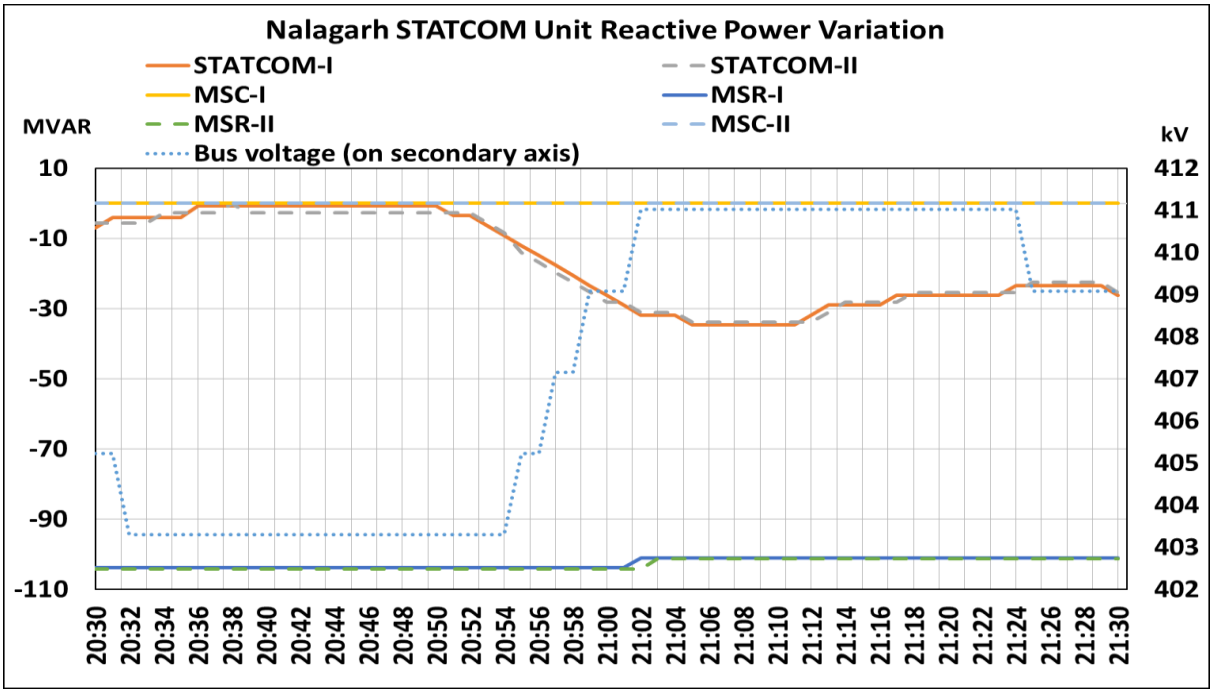

Variation of Reactive Power with respect to HV side voltage of unit
MONARCHAK GTG
MONARCHAK STG
MVAR
MONARCHAK Voltage (on sec. axis)
kV
16
14
12
10
8
6
4
2
0
-2
137.5
137
136.5
136
135.5
135
134.5
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

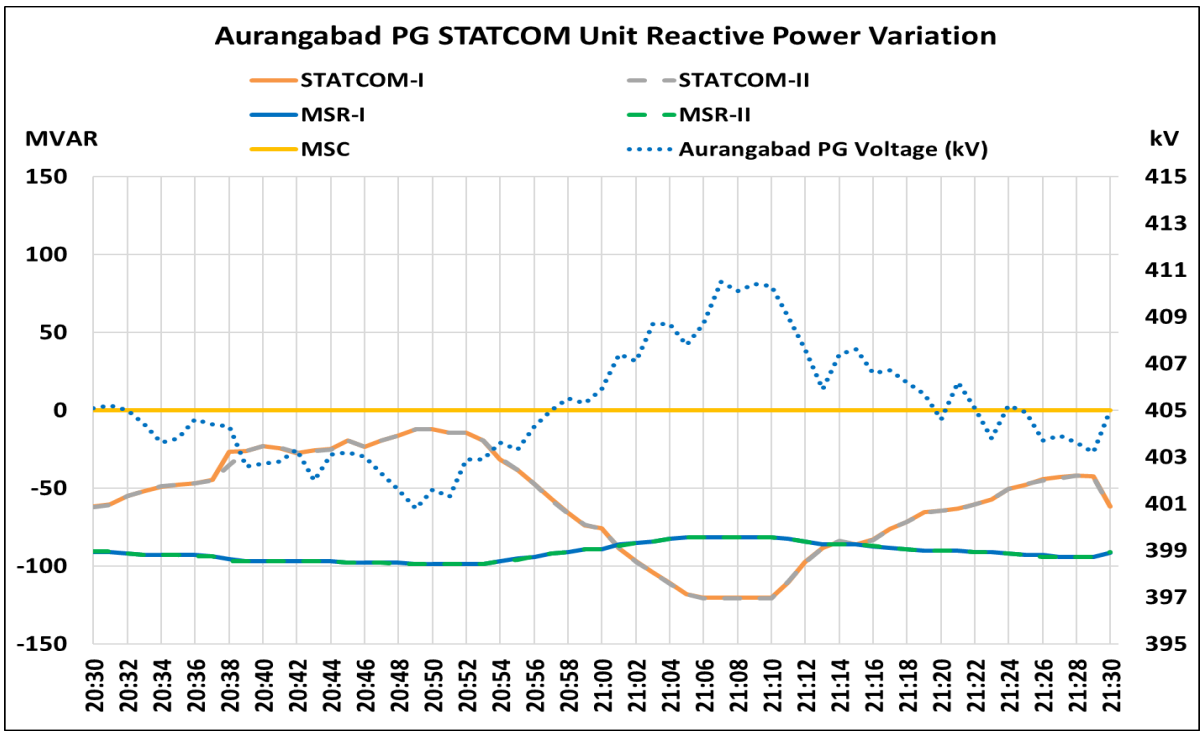

Variation of Reactive Power with respect to HV side voltage of unit
OTPC GTG- 1
OTPC GTG- 2
OTPC STG- 1
OTPC STG- 2
OTPC Bus Voltage (on sec. axis)
MVAR
kV
40
30
20
10
0
-10
-20
-30
-40
-50
416
414
412
410
408
406
404
402
400
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

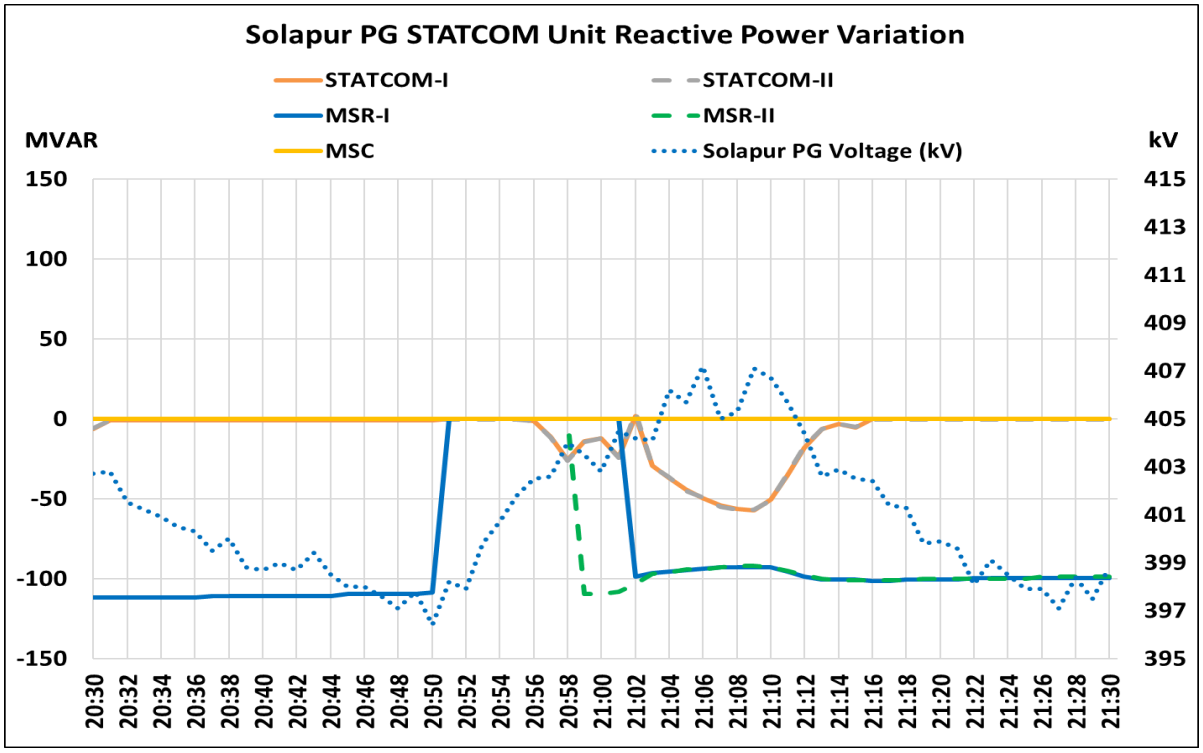

Variation of Reactive Power with respect to HV side voltage of unit
MVAR
PARE Unit- 1
PARE Bus Voltage (on sec. axis)
kV
1
0
-1
-2
-3
-4
-5
-6
-7
134.5
134
133.5
133
132.5
132
131.5
131
130.5
130
129.5
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

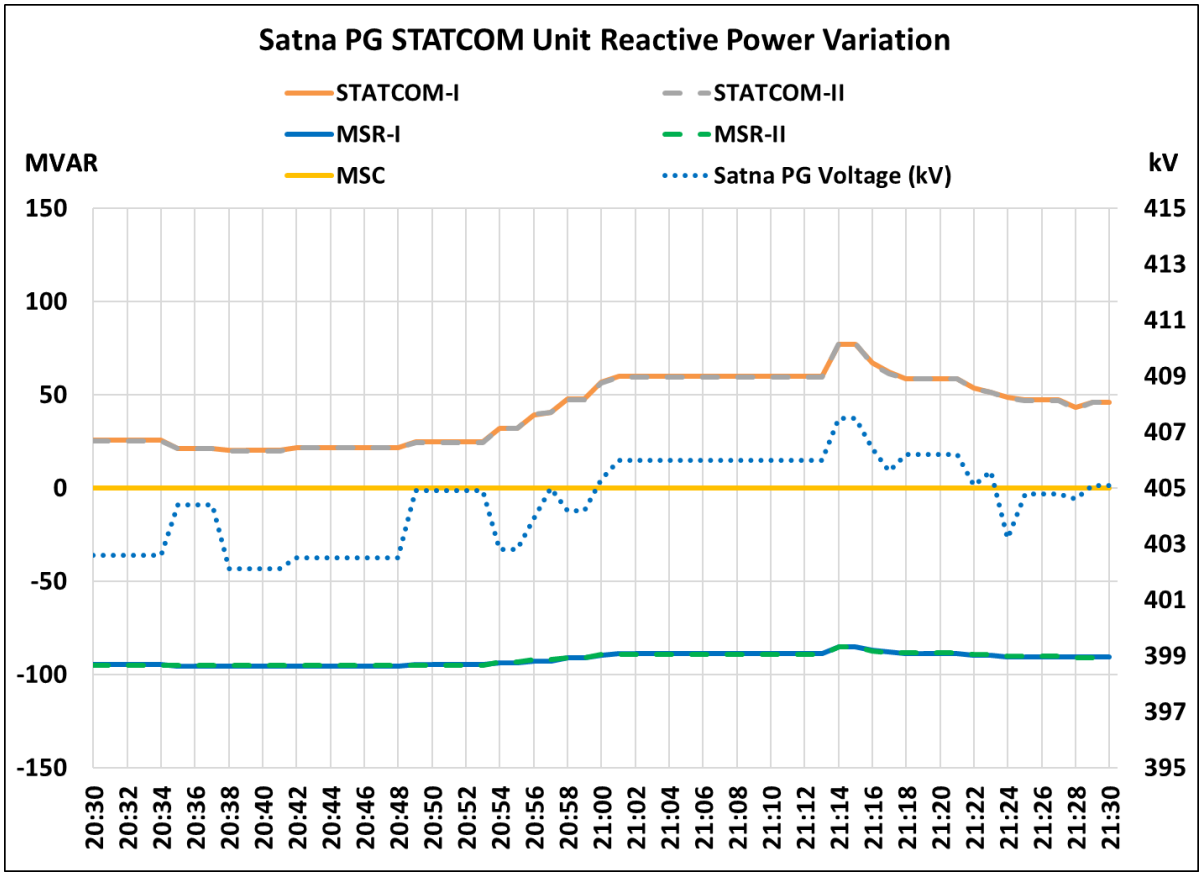

Variation of Reactive Power with respect to HV side voltage of unit
RHEP Unit- 1
RHEP Unit- 2
RHEP Unit- 3
RHEP Bus Voltage (on sec. axis)
MVAR
kV
30
20
10
0
-10
-20
-30
-40
416
414
412
410
408
406
404
402
400
398
396
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30

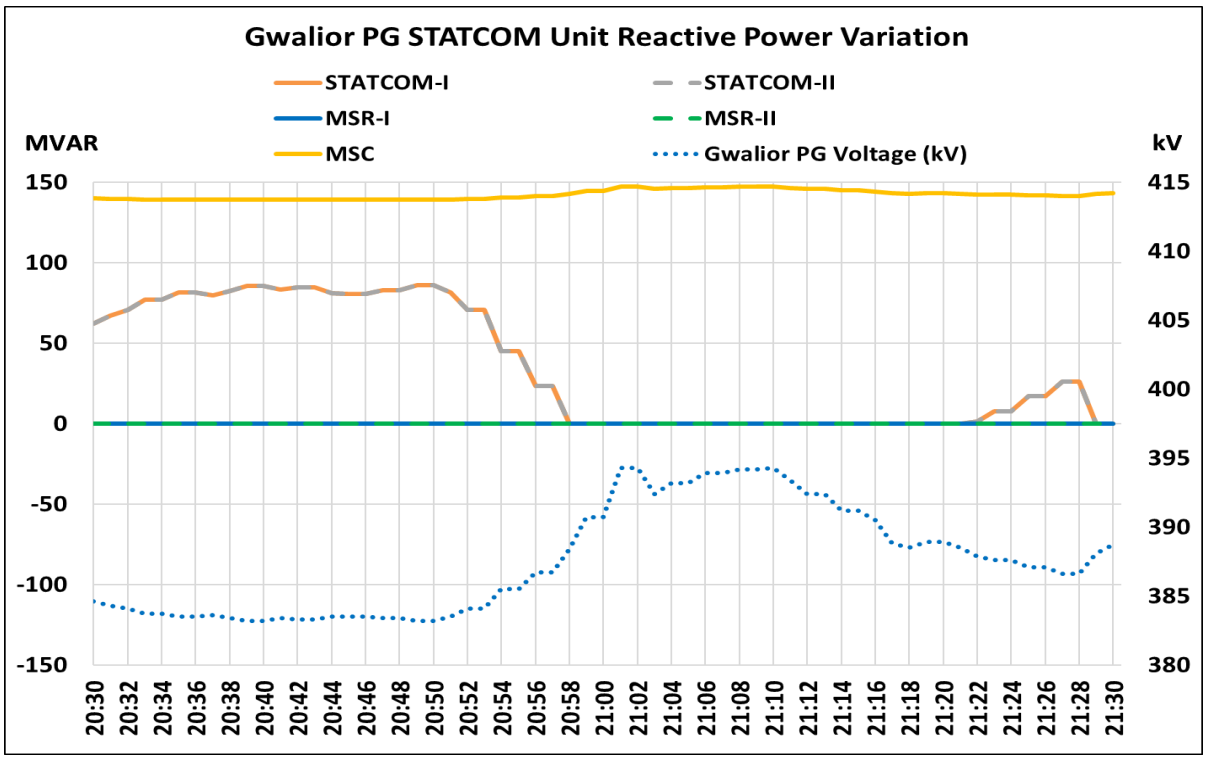
Annexure 11.2 Response of STATCOMs






Solapur PG STATCOM Unit Reactive Power Variation
STATCOM-I
STATCOM-II
MSR-I
MSR-II
MSC
Solapur PG Voltage (kV)
MVAR
kV
150
100
50
0
-50
-100
-150
415
413
411
409
407
405
403
401
399
397
395
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Satna PG STATCOM Unit Reactive Power Variation
STATCOM-I
STATCOM-II
MSR-I
MSR-II
MSC
Satna PG Voltage (kV)
MVAR
kV
150
100
50
0
-50
-100
-150
415
413
411
409
407
405
403
401
399
397
395
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Gwalior PG STATCOM Unit Reactive Power Variation
STATCOM-I
STATCOM-II
MSR-I
MSR-II
MSC
Gwalior PG Voltage (kV)
MVAR
kV
150
100
50
0
-50
-100
-150
415
410
405
400
395
390
385
380
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
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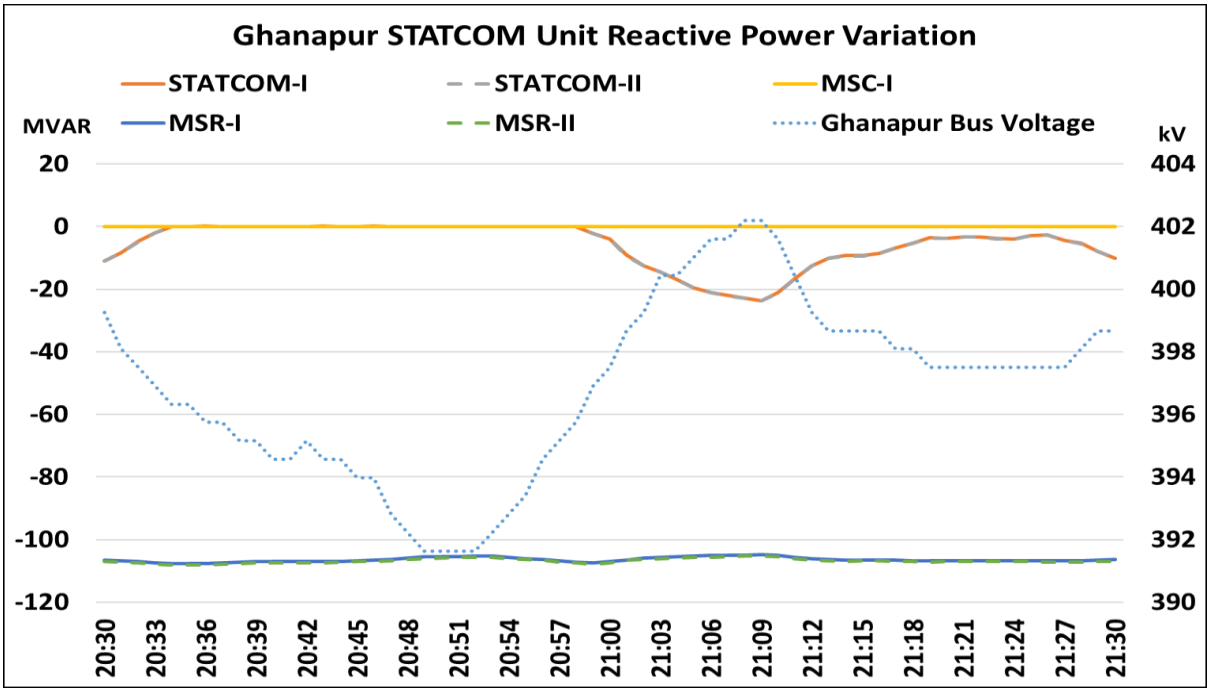
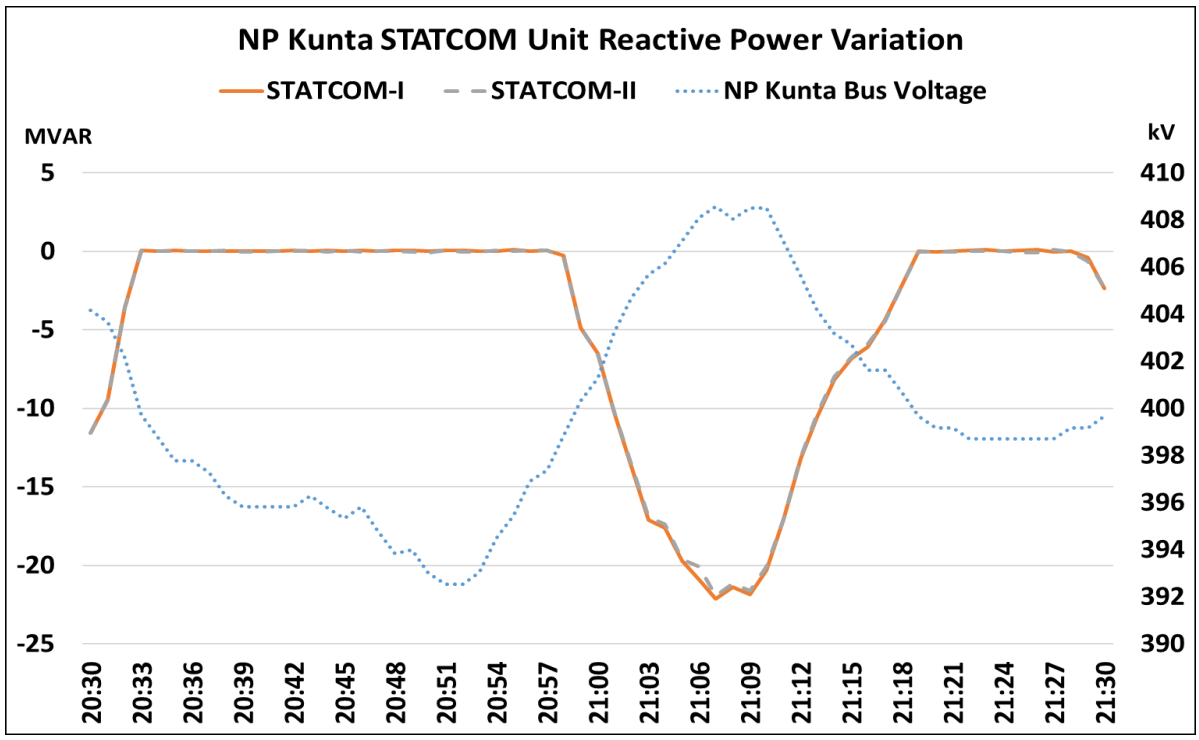
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Ghanapur STATCOM Unit Reactive Power Variation
STATCOM-I
STATCOM-II
MSC-I
MSR-I
MSR-II
Ghanapur Bus Voltage
MVAR
kV
20
0
-20
-40
-60
-80
-100
-120
404
402
400
398
396
394
392
390
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30


NP Kunta STATCOM Unit Reactive Power Variation
STATCOM-I
STATCOM-II
NP Kunta Bus Voltage
MVAR
kV
5
0
-5
-10
-15
-20
-25
410
408
406
404
402
400
398
396
394
392
390
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
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21:21
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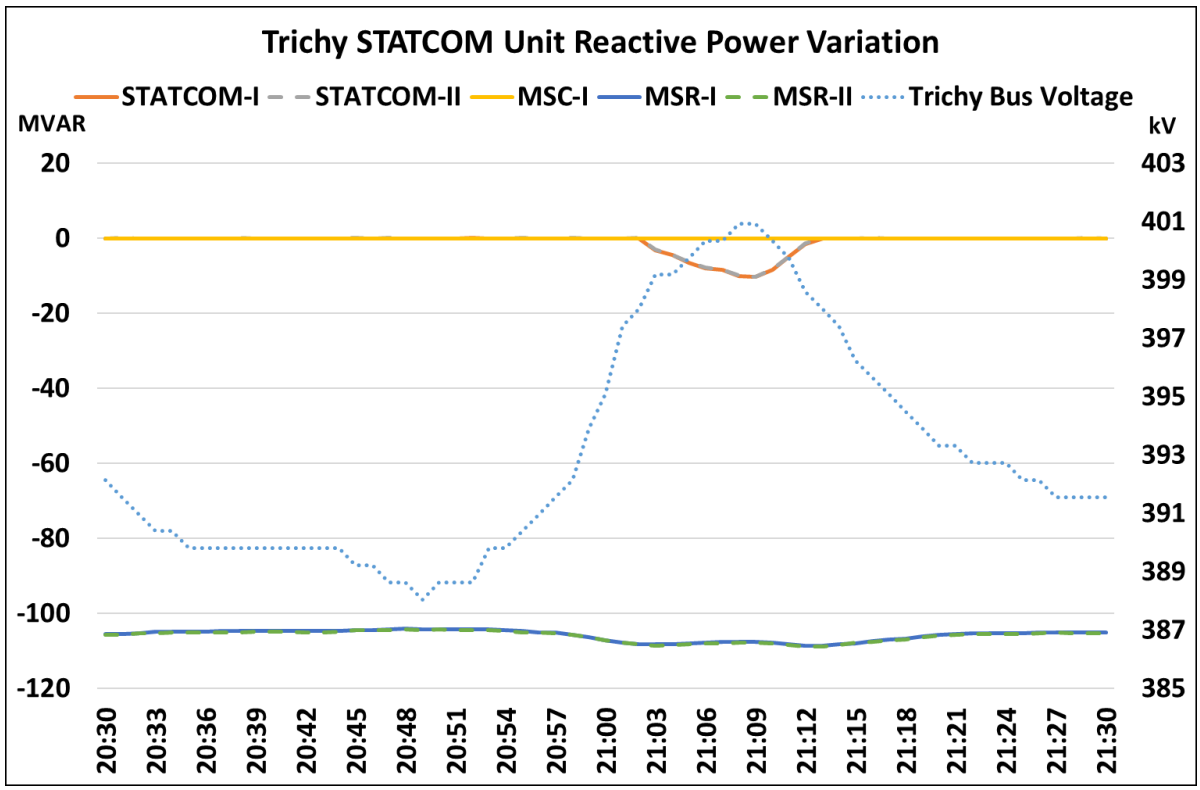
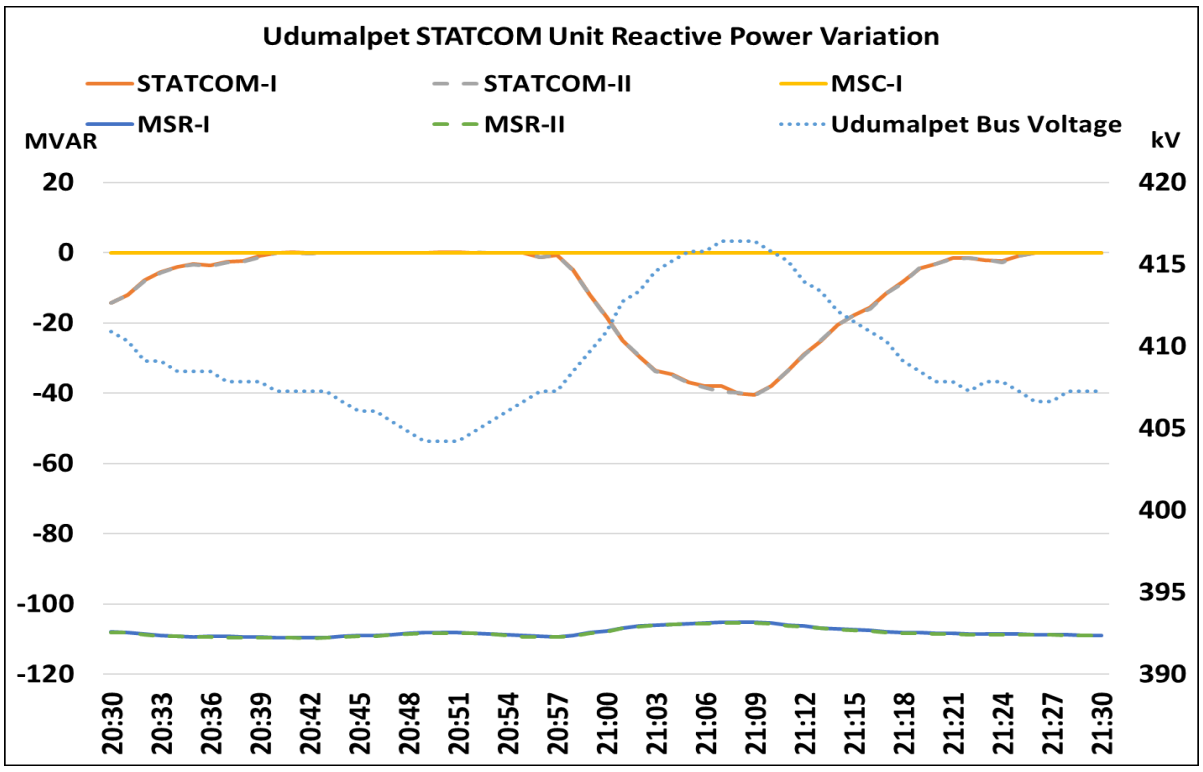
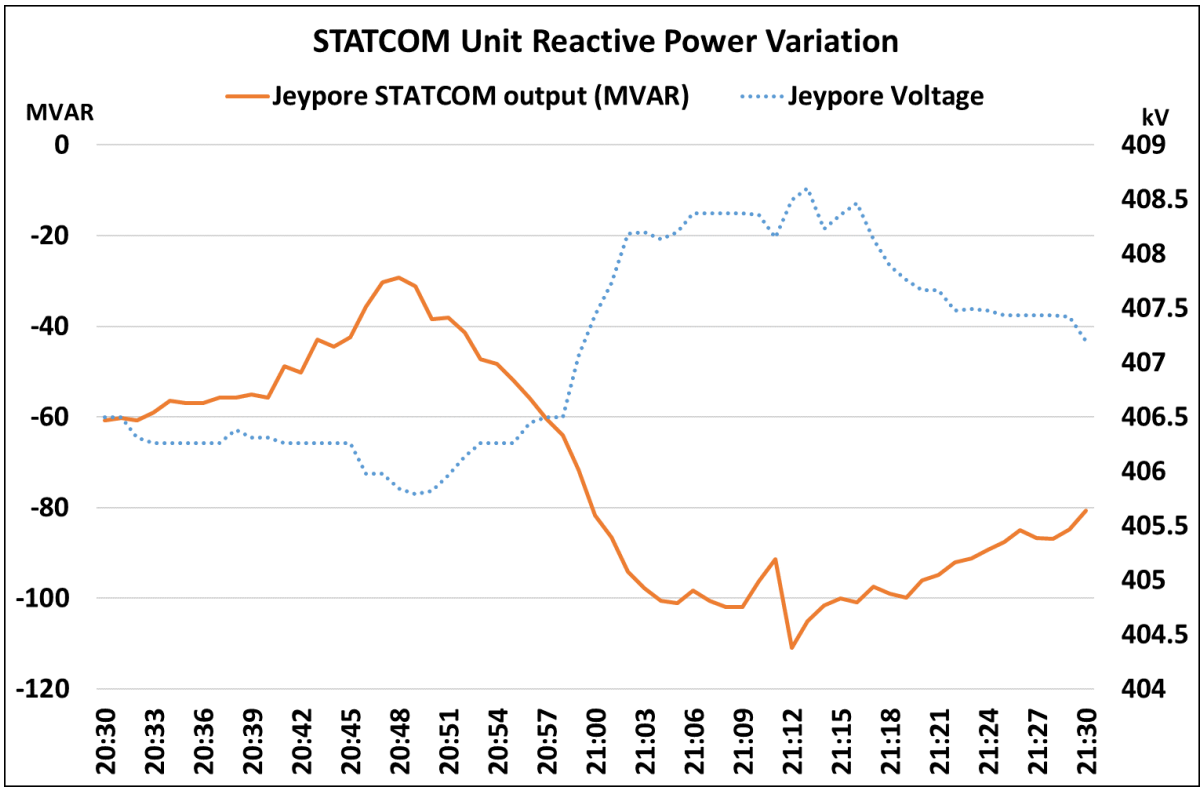
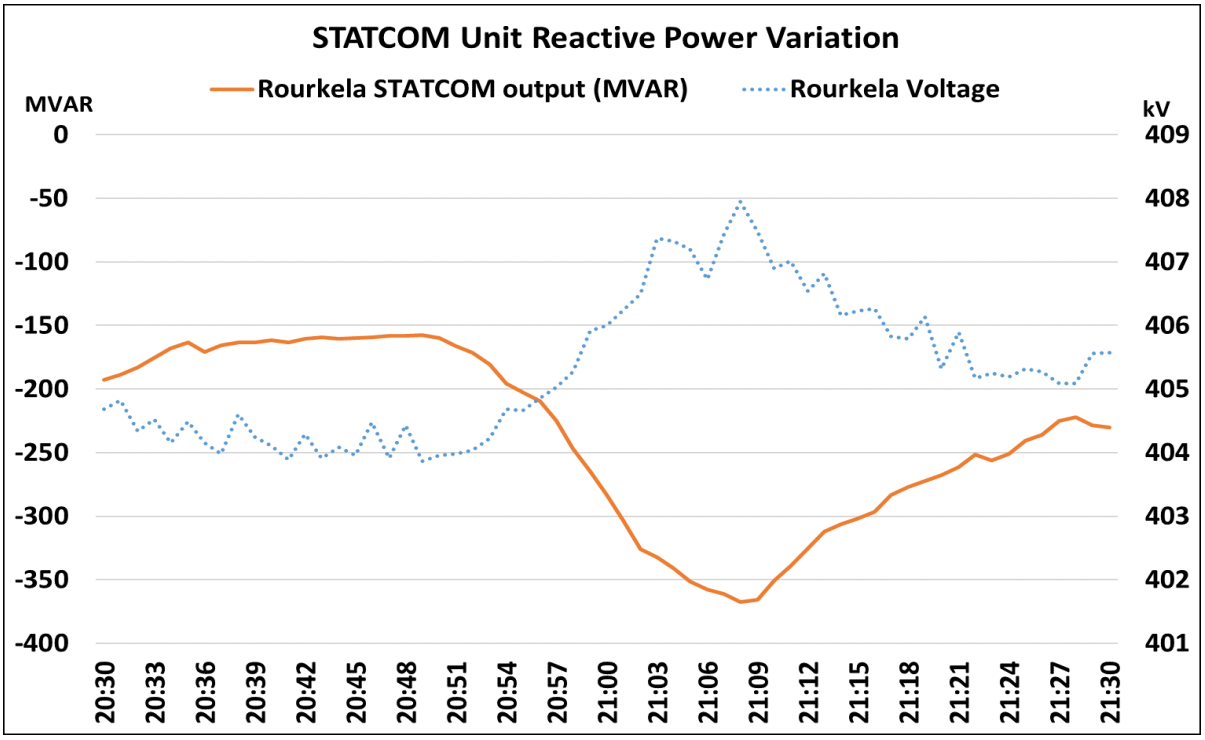
21:30


Trichy STATCOM Unit Reactive Power Variation
STATCOM-I
STATCOM-II
MSC-I
MSR-I
MSR-II
Trichy Bus Voltage
MVAR
kV
20
0
-20
-40
-60
-80
-100
-120
403
401
399
397
395
393
391
389
387
385
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30


Udumalpet STATCOM Unit Reactive Power Variation
STATCOM-I
STATCOM-II
MSC-I
MSR-I
MSR-II
Udumalpet Bus Voltage
MVAR
kV
20
0
-20
-40
-60
-80
-100
-120
420
415
410
405
400
395
390
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30


STATCOM Unit Reactive Power Variation
Jeypore STATCOM output (MVAR)
Jeypore Voltage
MVAR
kV
0
-20
-40
-60
-80
-100
-120
409
408.5
408
407.5
407
406.5
406
405.5
405
404.5
404
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30


STATCOM Unit Reactive Power Variation
Rourkela STATCOM output (MVAR)
Rourkela Voltage
MVAR
kV
0
-50
-100
-150
-200
-250
-300
-350
-400
409
408
407
406
405
404
403
402
401
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
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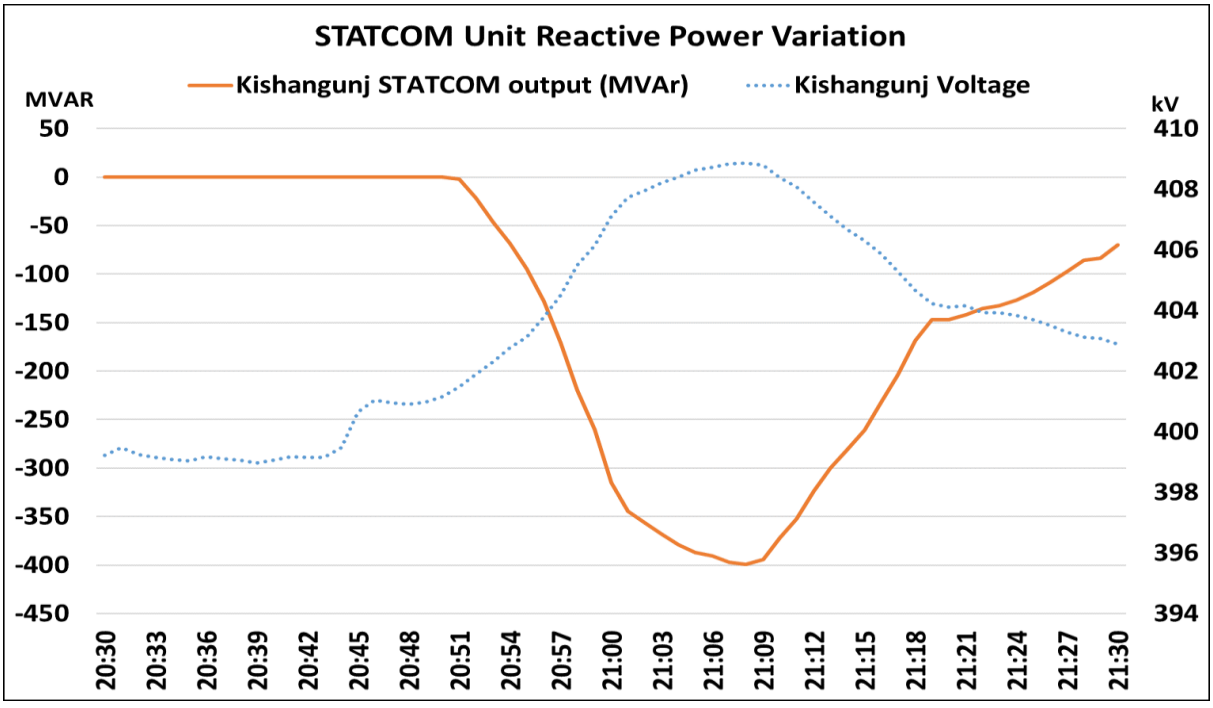
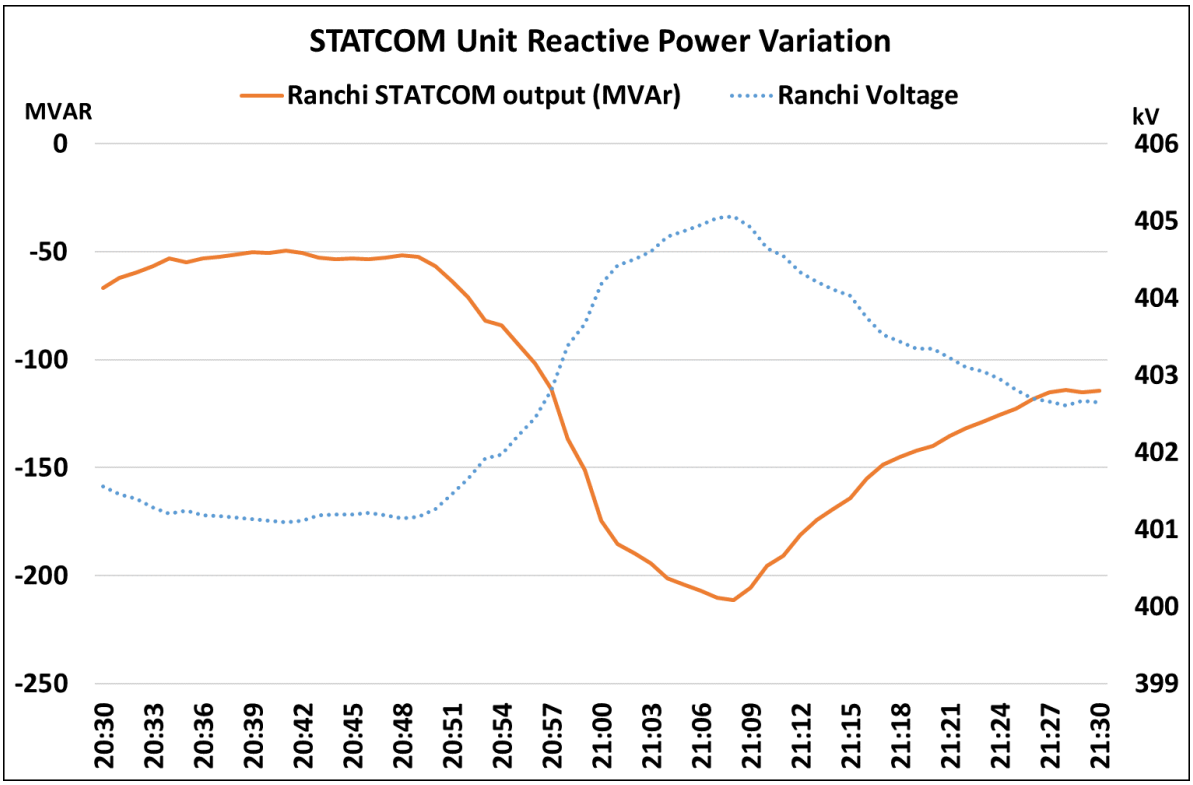
21:12
21:15
21:18
21:21
21:24
21:27
21:30


STATCOM Unit Reactive Power Variation
Kishangunj STATCOM output (MVAr)
Kishangunj Voltage
MVAR
kV
50
0
-50
-100
-150
-200
-250
-300
-350
-400
-450
410
408
406
404
402
400
398
396
394
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
21:06
21:09
21:12
21:15
21:18
21:21
21:24
21:27
21:30


STATCOM Unit Reactive Power Variation
Ranchi STATCOM output (MVAr)
Ranchi Voltage
MVAR
kV
0
-50
-100
-150
-200
-250
406
405
404
403
402
401
400
399
20:30
20:33
20:36
20:39
20:42
20:45
20:48
20:51
20:54
20:57
21:00
21:03
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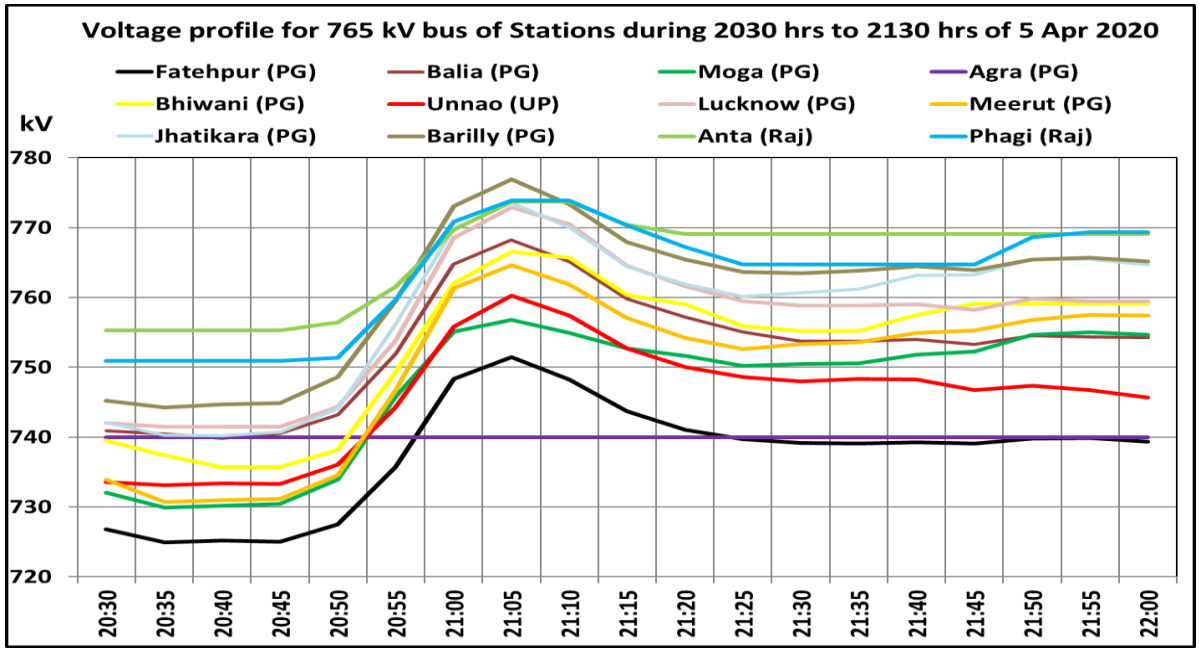
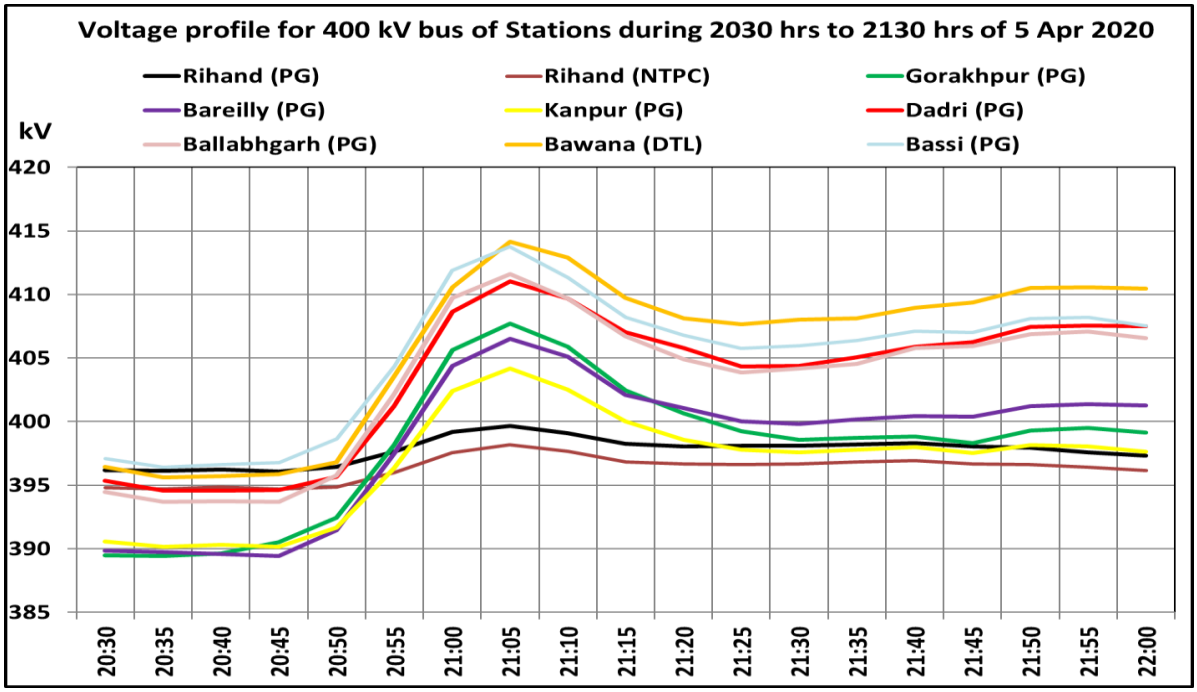
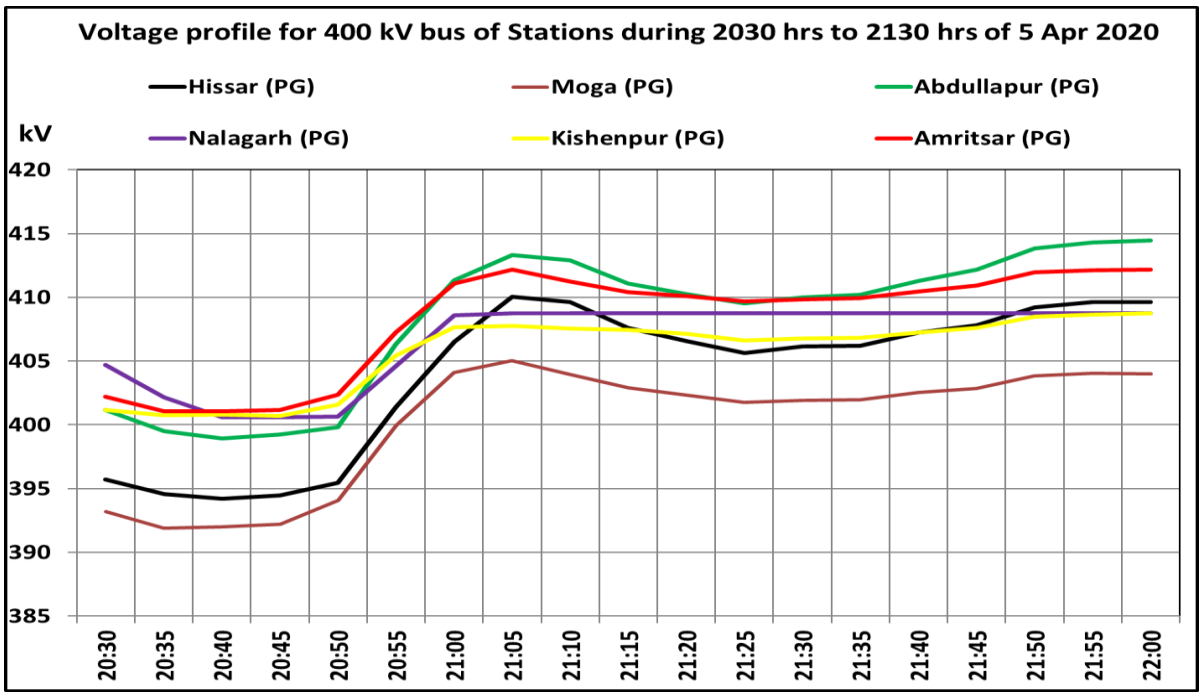
21:24
21:27
21:30

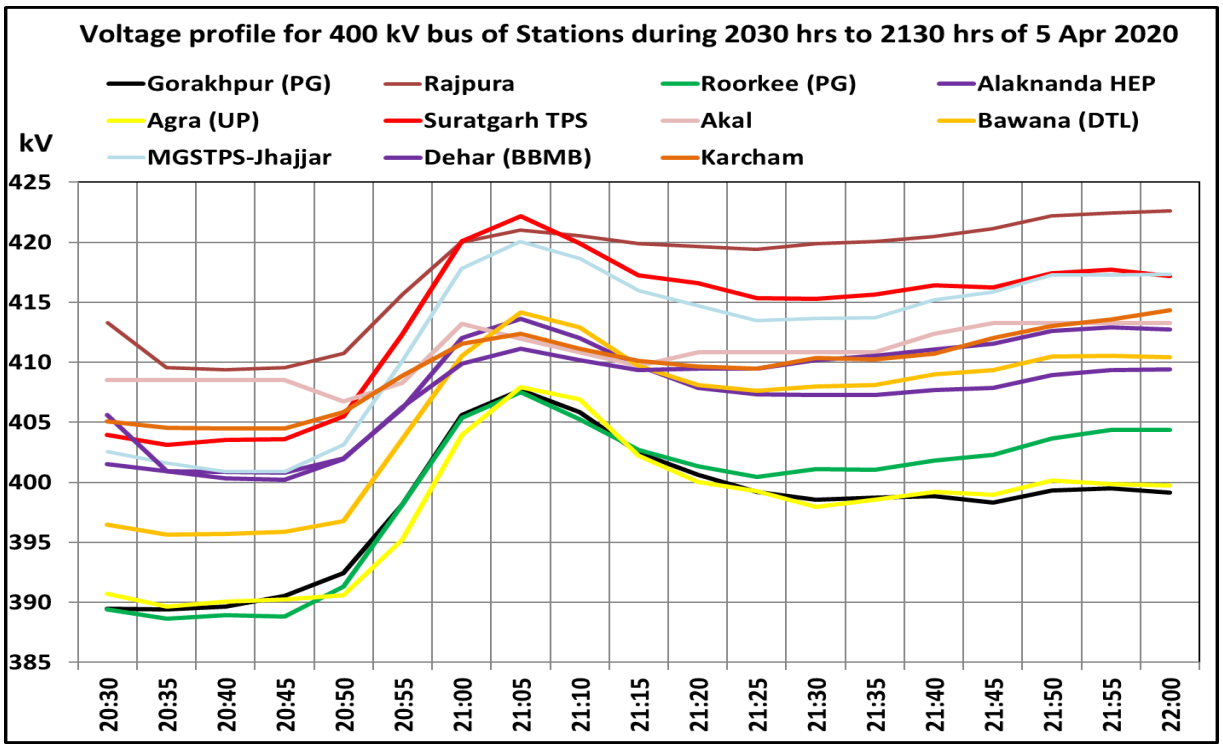
Annexure 11.3 Voltage Trend of 765 kV and 400 kV Stations

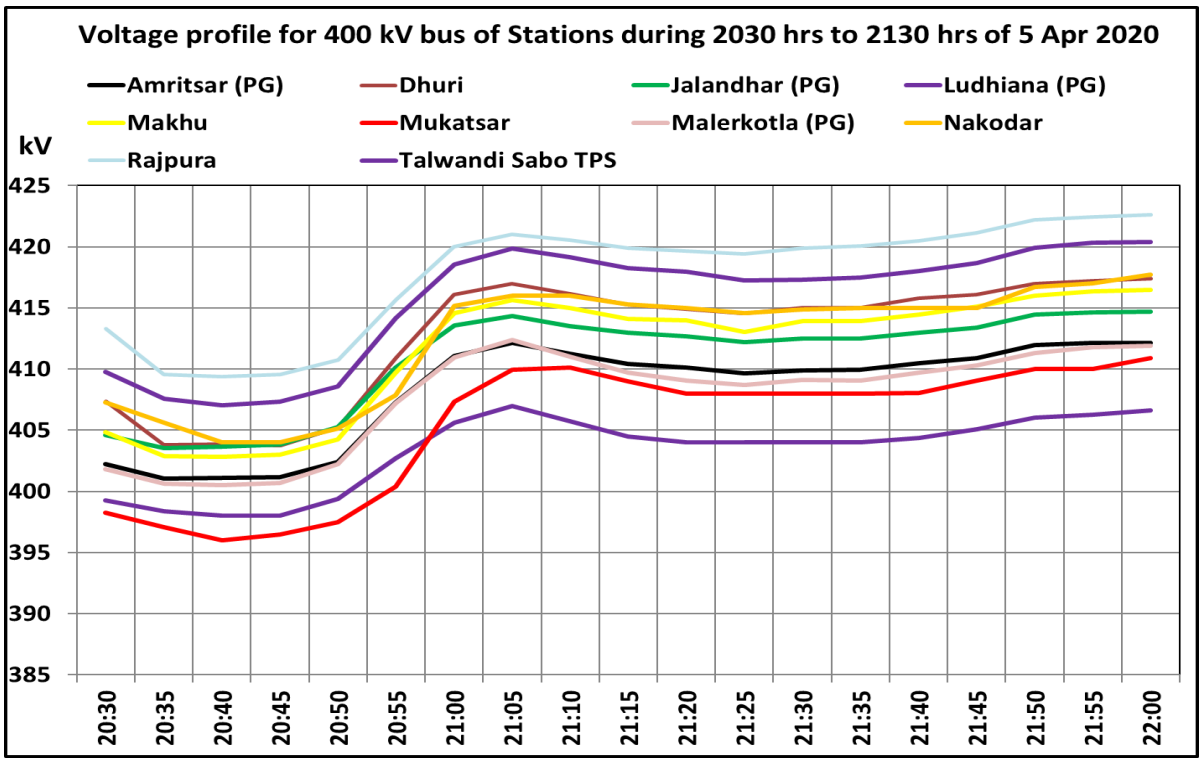
Northern region

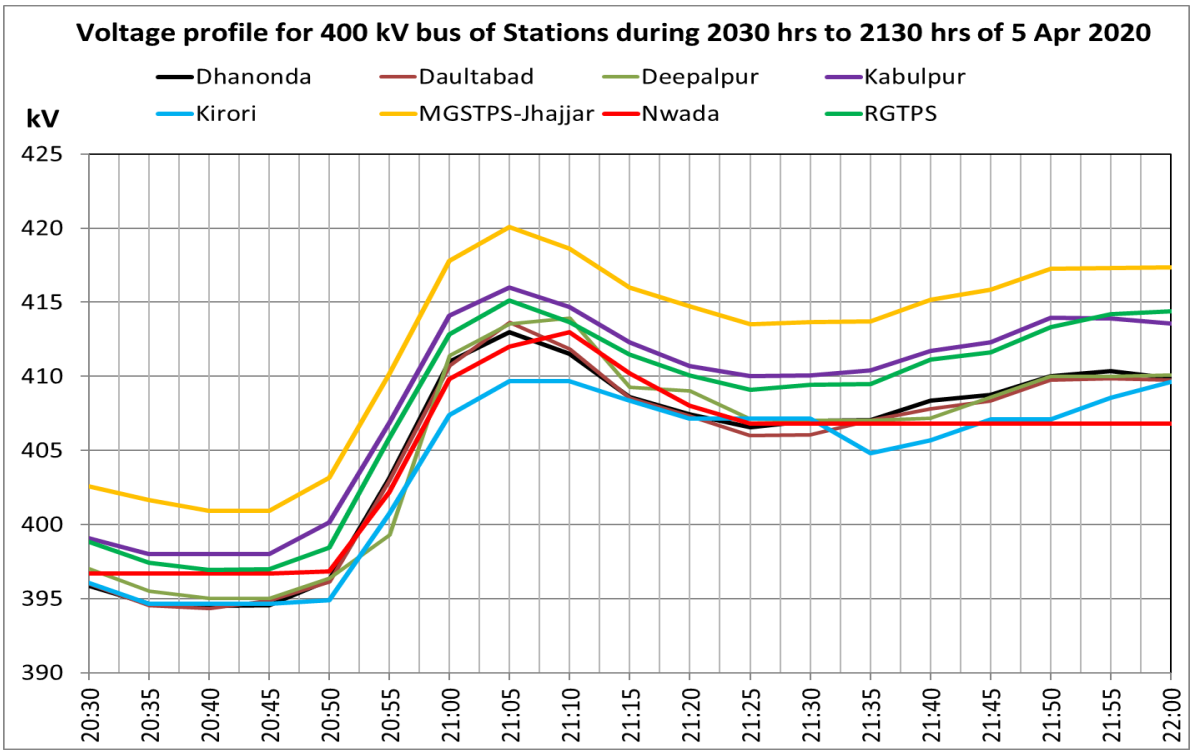


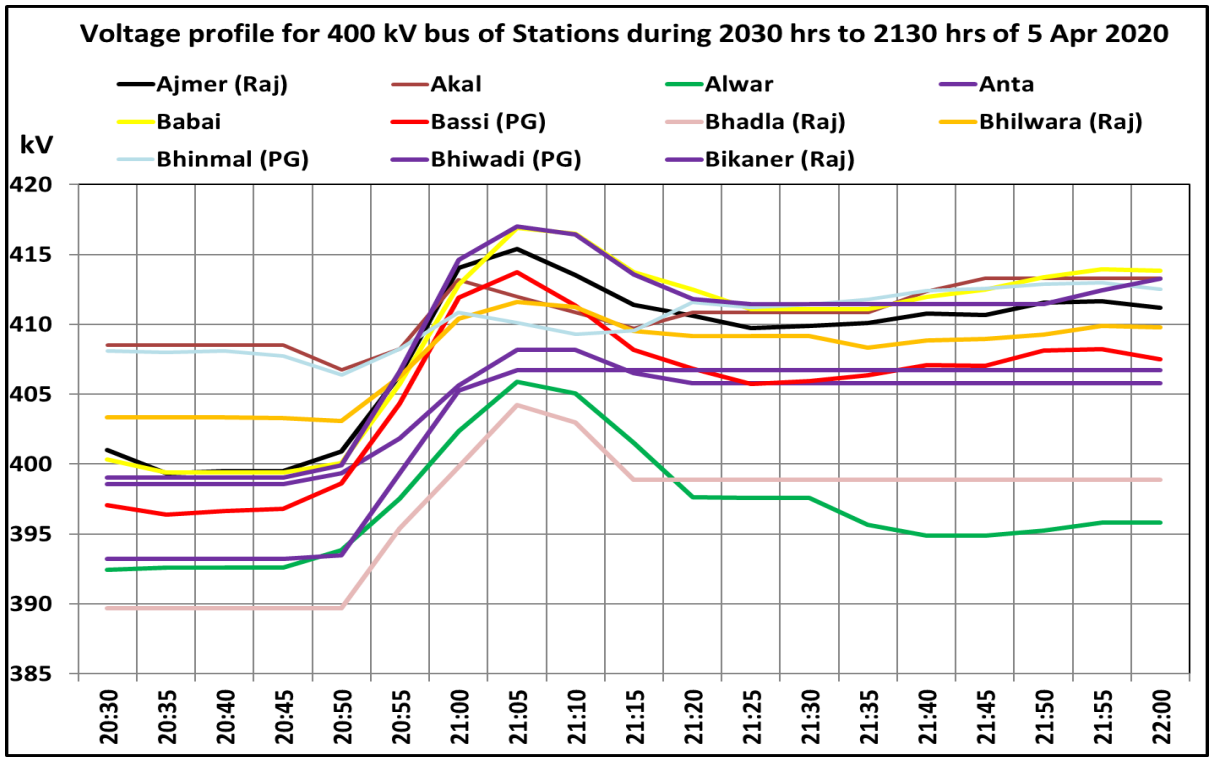


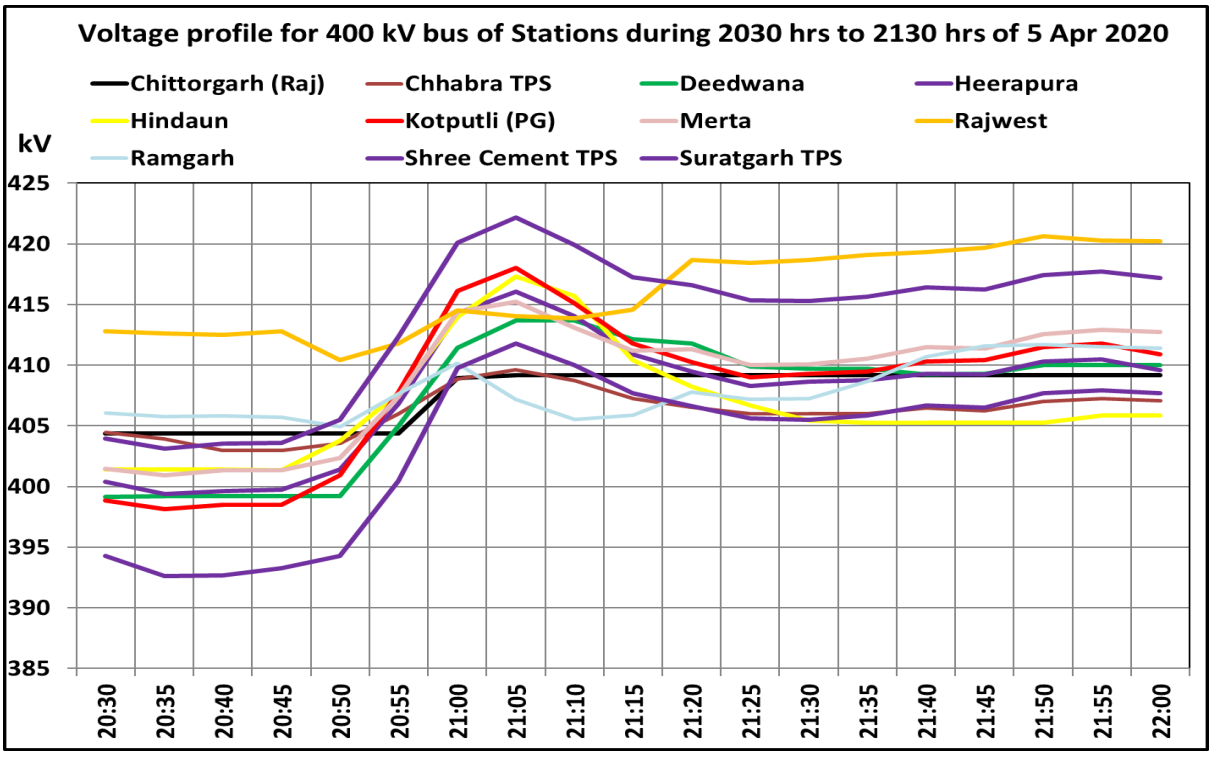

Voltage profile for 400 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
Hissar (PG)
Moga (PG)
Abdullapur (PG)
Nalagarh (PG)
Kishenpur (PG)
Amritsar (PG)
kV
420
415
410
405
400
395
390
385
20:30
20:35
20:40
20:45
20:50
20:55
21:00
21:05
21:10
21:15
21:20
21:25
21:30
21:35
21:40
21:45
21:50
21:55
22:00

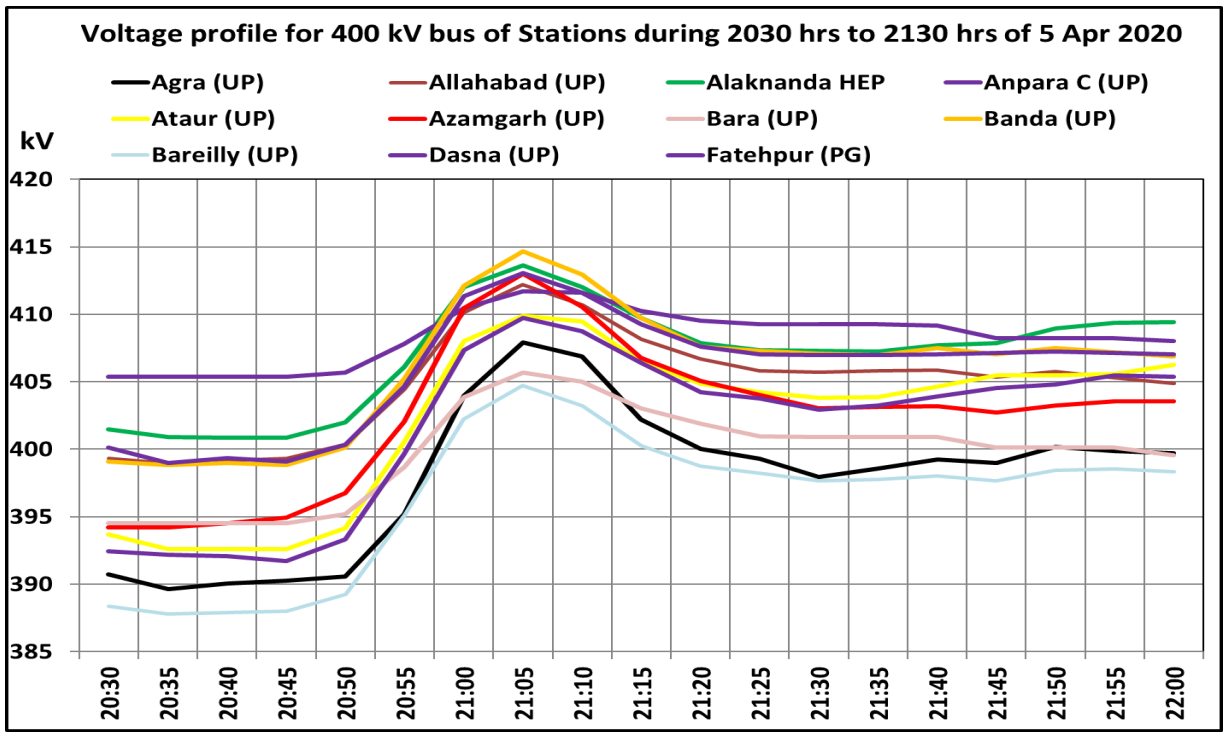

Voltage profile for 400 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
Gorakhpur (PG)
Rajpura
Roorkee (PG)
Alaknanda HEP
Agra (UP)
Suratgarh TPS
Akal
Bawana (DTL)
MGSTPS-Jhajjar
Dehar (BBMB)
Karcham
kV
425
420
415
410
405
400
395
390
385
20:30
20:35
20:40
20:45
20:50
20:55
21:00
21:05
21:10
21:15
21:20
21:25
21:30
21:35
21:40
21:45
21:50
21:55
22:00

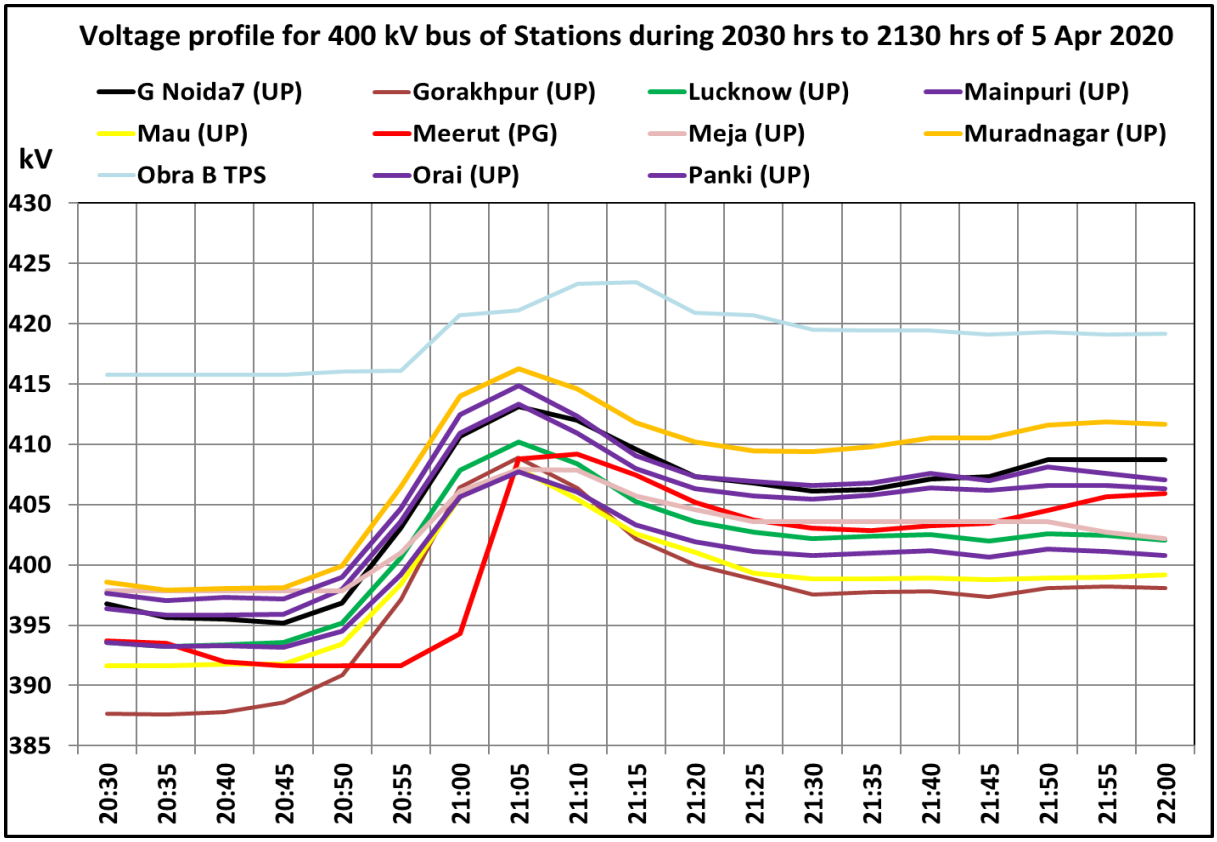

Voltage profile for 400 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
Amritsar (PG)
Dhuri
Jalandhar (PG)
Ludhiana (PG)
Makhu
Mukatsar
Malerkotla (PG)
Nakodar
Rajpura
Talwandi Sabo TPS
kV
425
420
415
410
405
400
395
390
385
20:30
20:35
20:40
20:45
20:50
20:55
21:00
21:05
21:10
21:15
21:20
21:25
21:30
21:35
21:40
21:45
21:50
21:55
22:00

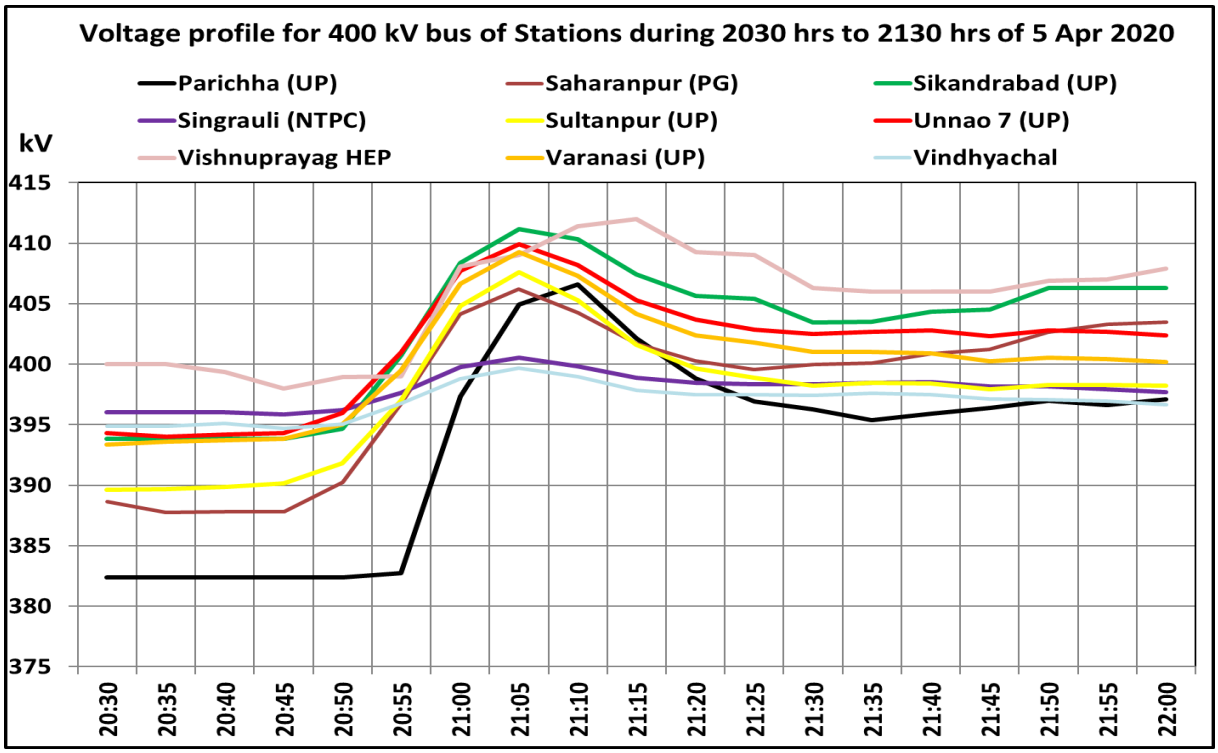

Voltage profile for 400 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
Dhanonda
Daultabad
Deepalpur
Kabulpur
Kirori
MGSTPS-Jhajjar
Nwada
RGTPS
kV
425
420
415
410
405
400
395
390
20:30
20:35
20:40
20:45
20:50
20:55
21:00
21:05
21:10
21:15
21:20
21:25
21:30
21:35
21:40
21:45
21:50
21:55
22:00

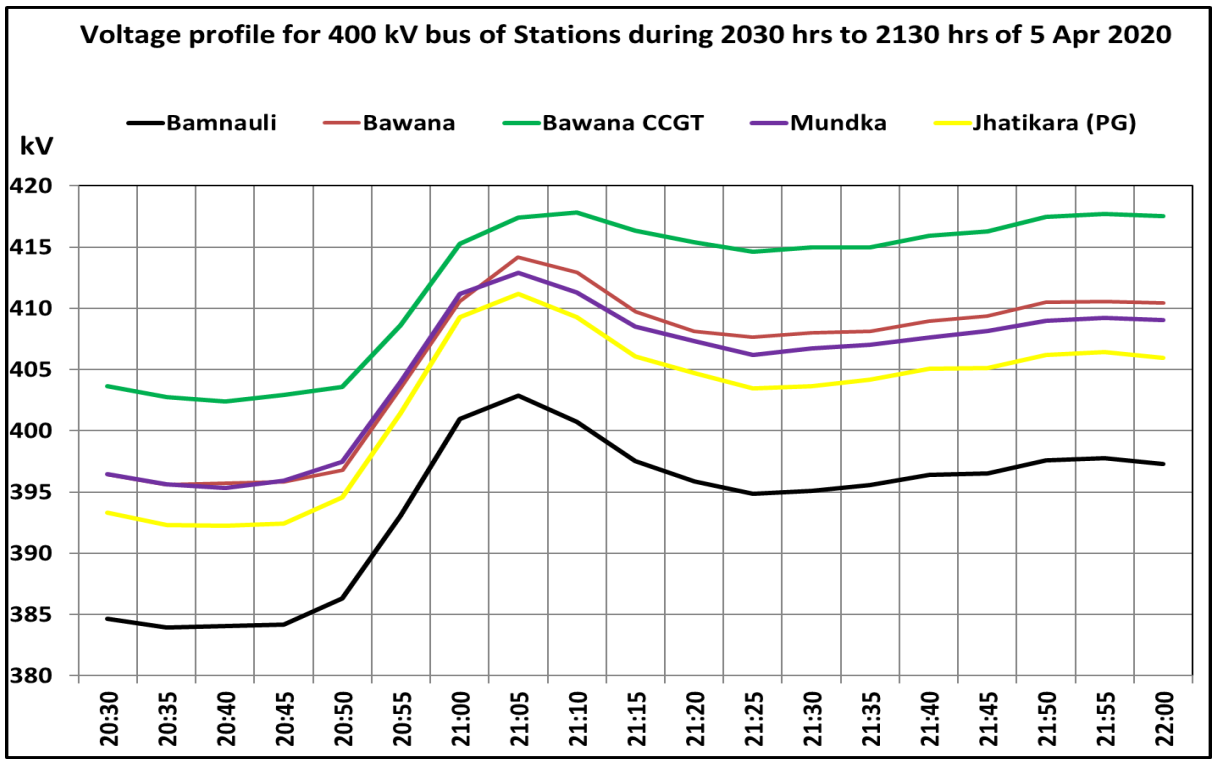

Voltage profile for 400 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
Ajmer (Raj)
Akal
Alwar
Anta
Babai
Bassi (PG)
Bhadla (Raj)
Bhilwara (Raj)
Bhinmal (PG)
Bhiwadi (PG)
Bikaner (Raj)
kV
420
415
410
405
400
395
390
385
20:30
20:35
20:40
20:45
20:50
20:55
21:00
21:05
21:10
21:15
21:20
21:25
21:30
21:35
21:40
21:45
21:50
21:55
22:00

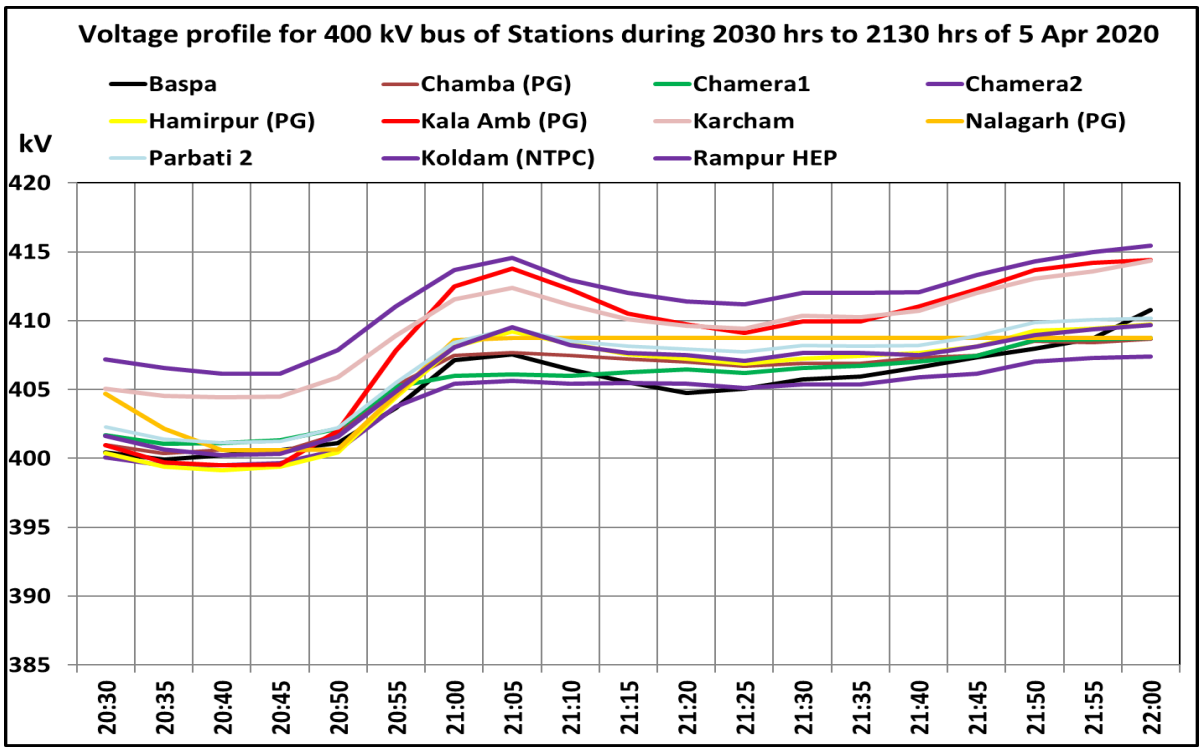

Voltage profile for 400 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
Chittorgarh (Raj)
Chhabra TPS
Deedwana
Heerapura
Hindaun
Kotputli (PG)
Merta
Rajwest
Ramgarh
Shree Cement TPS
Suratgarh TPS
kV
425
420
415
410
405
400
395
390
385
20:30
20:35
20:40
20:45
20:50
20:55
21:00
21:05
21:10
21:15
21:20
21:25
21:30
21:35
21:40
21:45
21:50
21:55
22:00

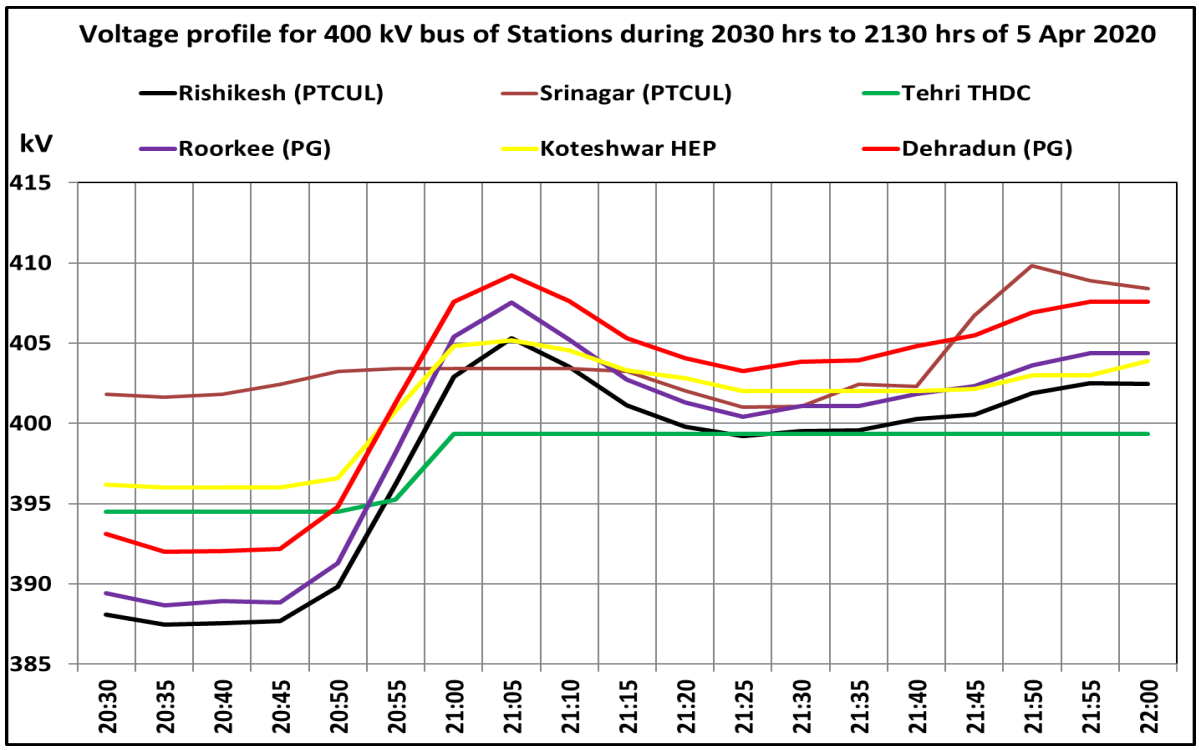

Voltage profile for 400 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
Agra (UP)
Allahabad (UP)
Alaknanda HEP
Anpara C (UP)
Ataur (UP)
Azamgarh (UP)
Bara (UP)
Banda (UP)
Bareilly (UP)
Dasna (UP)
Fatehpur (PG)
kV
420
415
410
405
400
395
390
385
20:30
20:35
20:40
20:45
20:50
20:55
21:00
21:05
21:10
21:15
21:20
21:25
21:30
21:35
21:40
21:45
21:50
21:55
22:00


Voltage profile for 400 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
G Noida7 (UP)
Gorakhpur (UP)
Lucknow (UP)
Mainpuri (UP)
Mau (UP)
Meerut (PG)
Meja (UP)
Muradnagar (UP)
Obra B TPS
Orai (UP)
Panki (UP)
kV
430
425
420
415
410
405
400
395
390
385
20:30
20:35
20:40
20:45
20:50
20:55
21:00
21:05
21:10
21:15
21:20
21:25
21:30
21:35
21:40
21:45
21:50
21:55
22:00


Voltage profile for 400 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
Parichha (UP)
Saharanpur (PG)
Sikandrabad (UP)
Singrauli (NTPC)
Sultanpur (UP)
Unnao 7 (UP)
Vishnuprayag HEP
Varanasi (UP)
Vindhyachal
kV
415
410
405
400
395
390
385
380
375
20:30
20:35
20:40
20:45
20:50
20:55
21:00
21:05
21:10
21:15
21:20
21:25
21:30
21:35
21:40
21:45
21:50
21:55
22:00


Voltage profile for 400 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
Bamnauli
Bawana
Bawana CCGT
Mundka
Jhatikara (PG)
kV
420
415
410
405
400
395
390
385
380
20:30
20:35
20:40
20:45
20:50
20:55
21:00
21:05
21:10
21:15
21:20
21:25
21:30
21:35
21:40
21:45
21:50
21:55
22:00


Voltage profile for 400 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
Baspa
Chamba (PG)
Chamera1
Chamera2
Hamirpur (PG)
Kala Amb (PG)
Karcham
Nalagarh (PG)
Parbati 2
Koldam (NTPC)
Rampur HEP
kV
420
415
410
405
400
395
390
385
20:30
20:35
20:40
20:45
20:50
20:55
21:00
21:05
21:10
21:15
21:20
21:25
21:30
21:35
21:40
21:45
21:50
21:55
22:00


Voltage profile for 400 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
Rishikesh (PTCUL)
Srinagar (PTCUL)
Tehri THDC
Roorkee (PG)
Koteshwar HEP
Dehradun (PG)
kV
415
410
405
400
395
390
385
20:30
20:35
20:40
20:45
20:50
20:55
21:00
21:05
21:10
21:15
21:20
21:25
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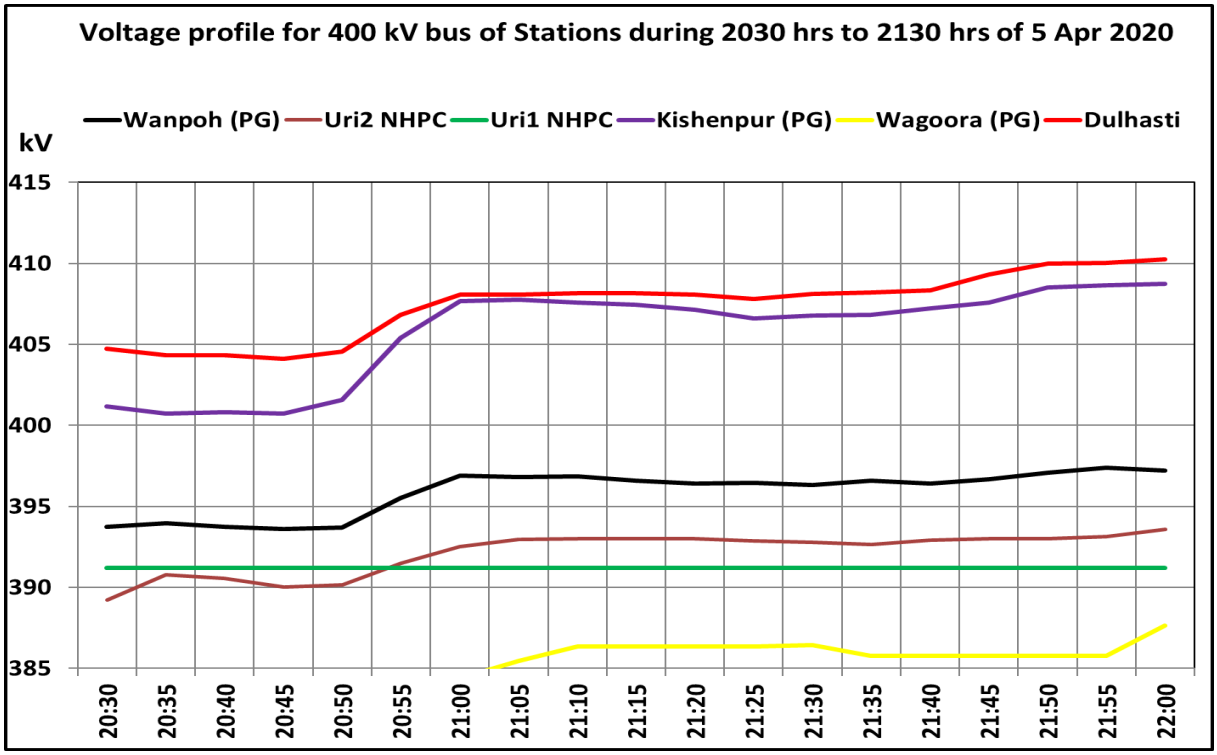
21:35
21:40
21:45
21:50
21:55
22:00


Voltage profile for 400 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
Wanpoh (PG)
Uri2 NHPC
Uri1 NHPC
Kishenpur (PG)
Wagoora (PG)
Dulhasti
kV
415
410
405
400
395
390
385
20:30
20:35
20:40
20:45
20:50
20:55
21:00
21:05
21:10
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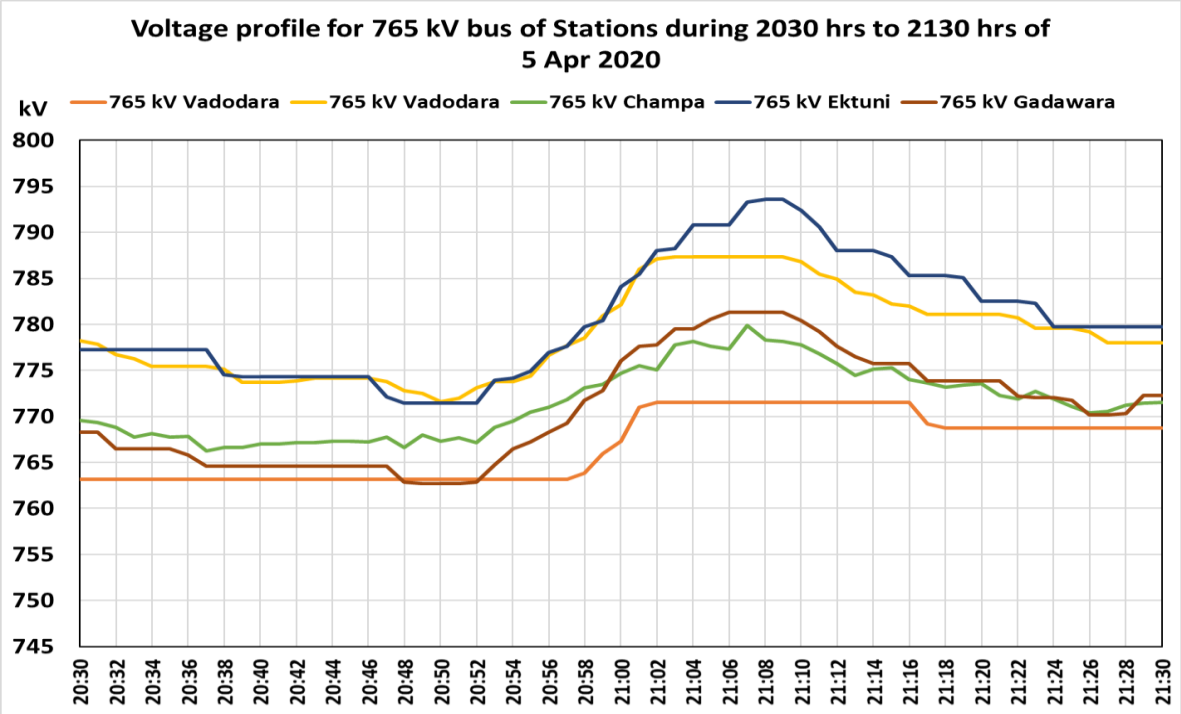
21:35
21:40
21:45
21:50
21:55
22:00


Voltage profile for 765 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
kV
765 kV Vadodara
765 kV Vadodara
765 kV Champa
765 kV Ektuni
765 kV Gadawara
800
795
790
785
780
775
770
765
760
755
750
745
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
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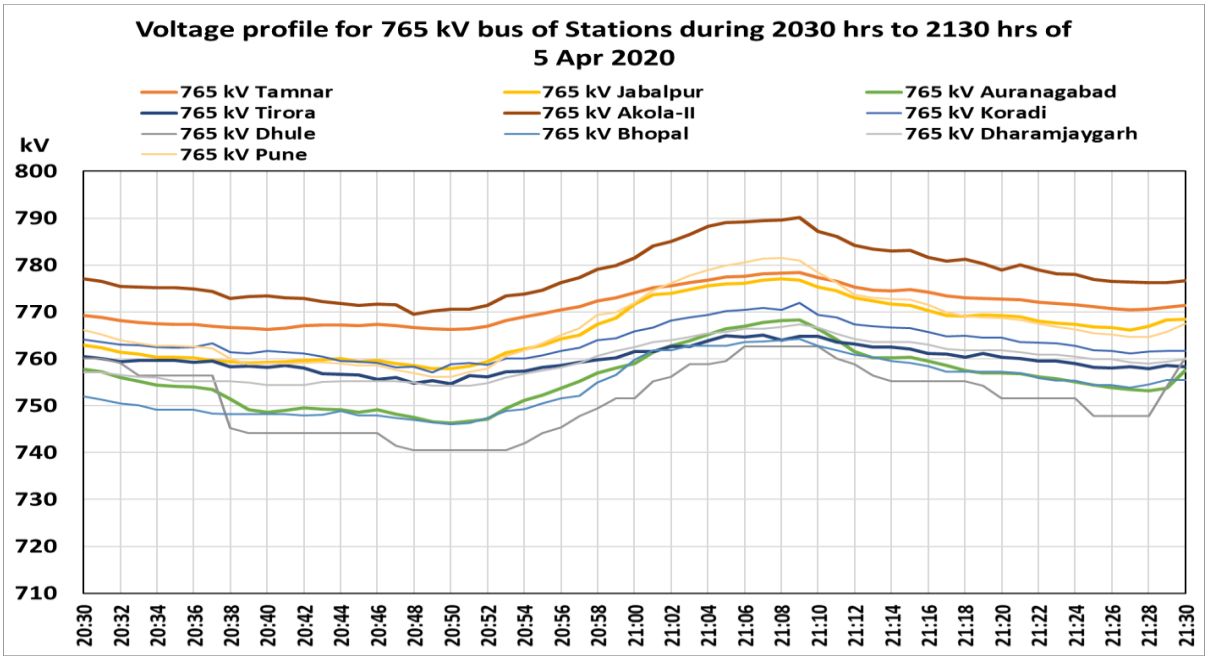
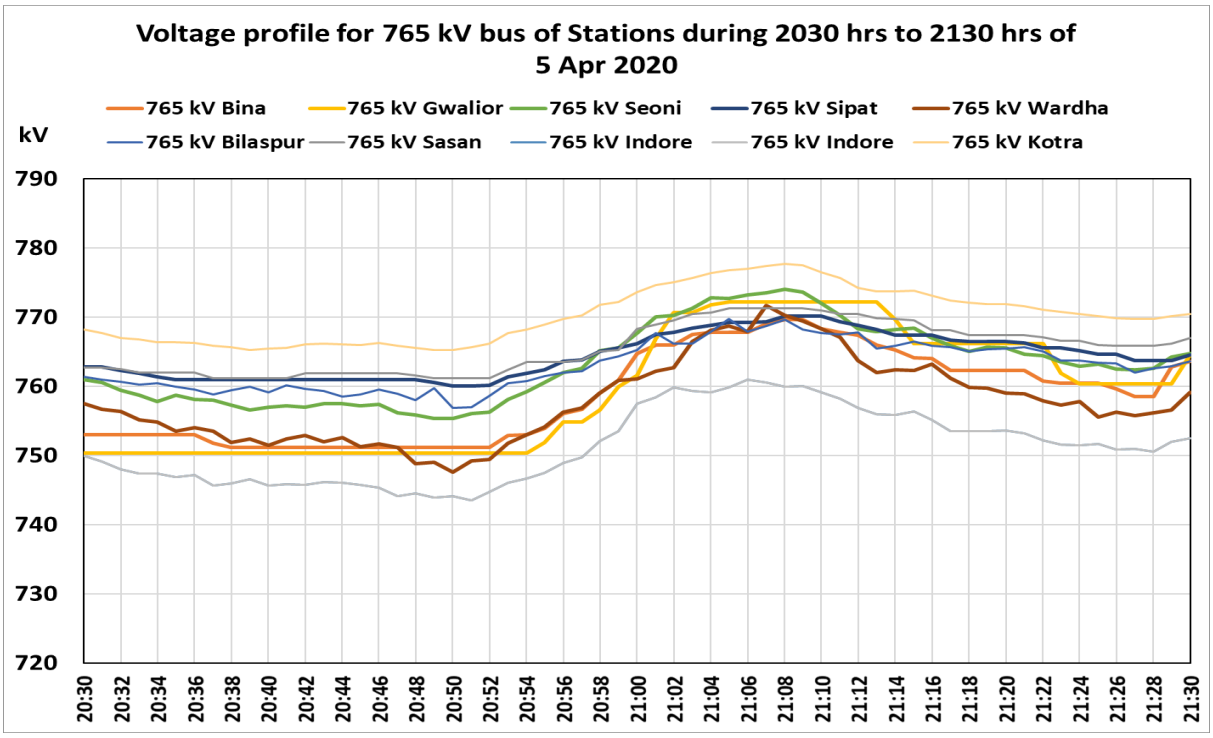
21:20
21:22
21:24
21:26
21:28
21:30


Voltage profile for 765 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
765 kV Tamnar
765 kV Jabalpur
765 kV Auranagabad
765 kV Tirora
765 kV Akola-II
765 kV Koradi
765 kV Dhule
765 kV Bhopal
765 kV Dharamjaygarh
765 kV Pune
kV
800
790
780
770
760
750
740
730
720
710
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
21:06
21:08
21:10
21:12
21:14
21:16
21:18
21:20
21:22
21:24
21:26
21:28
21:30


Voltage profile for 765 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
765 kV Bina
765 kV Gwalior
765 kV Seoni
765 kV Sipat
765 kV Wardha
765 kV Bilaspur
765 kV Sasan
765 kV Indore
765 kV Indore
765 kV Kotra
kV
790
780
770
760
750
740
730
720
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
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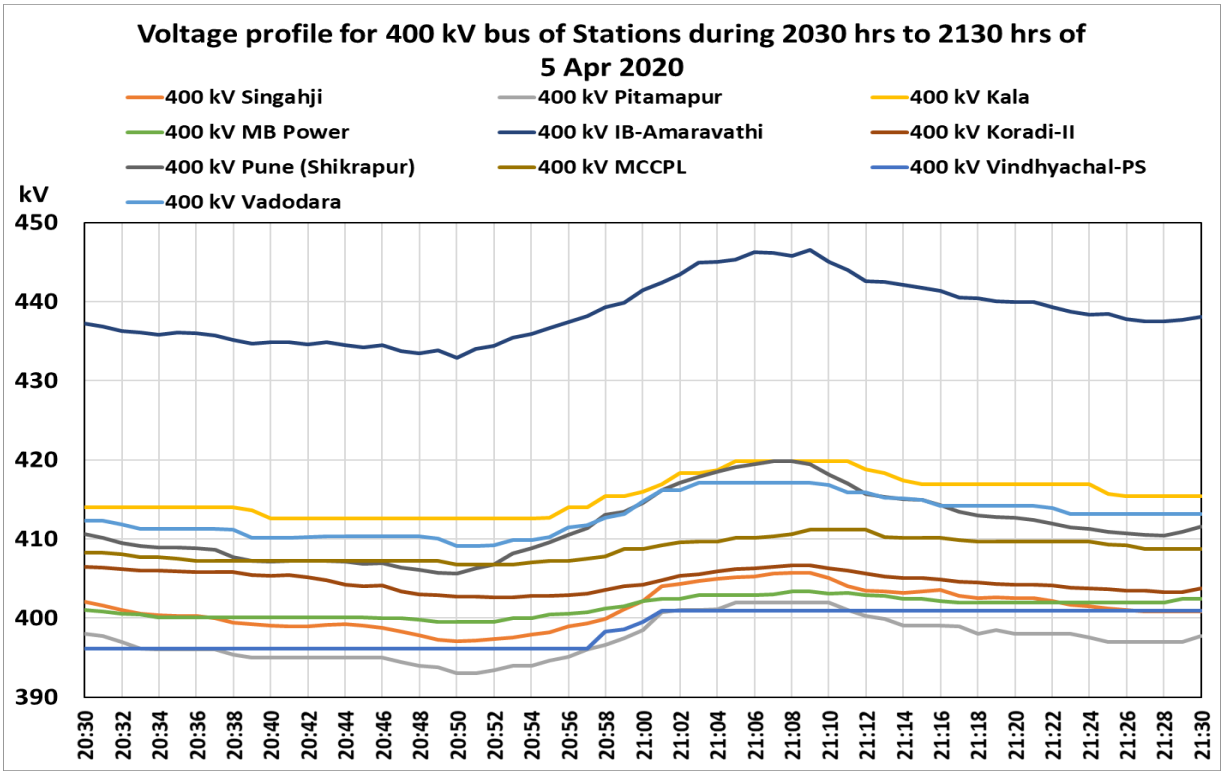
Voltage profile for 400 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
400 kV Singahji
400 kV Pitamapur
400 kV Kala
400 kV MB Power
400 kV IB-Amaravathi
400 kV Koradi-II
400 kV Pune (Shikrapur)
400 kV MCCPL
400 kV Vindhyachal-PS
400 kV Vadodara
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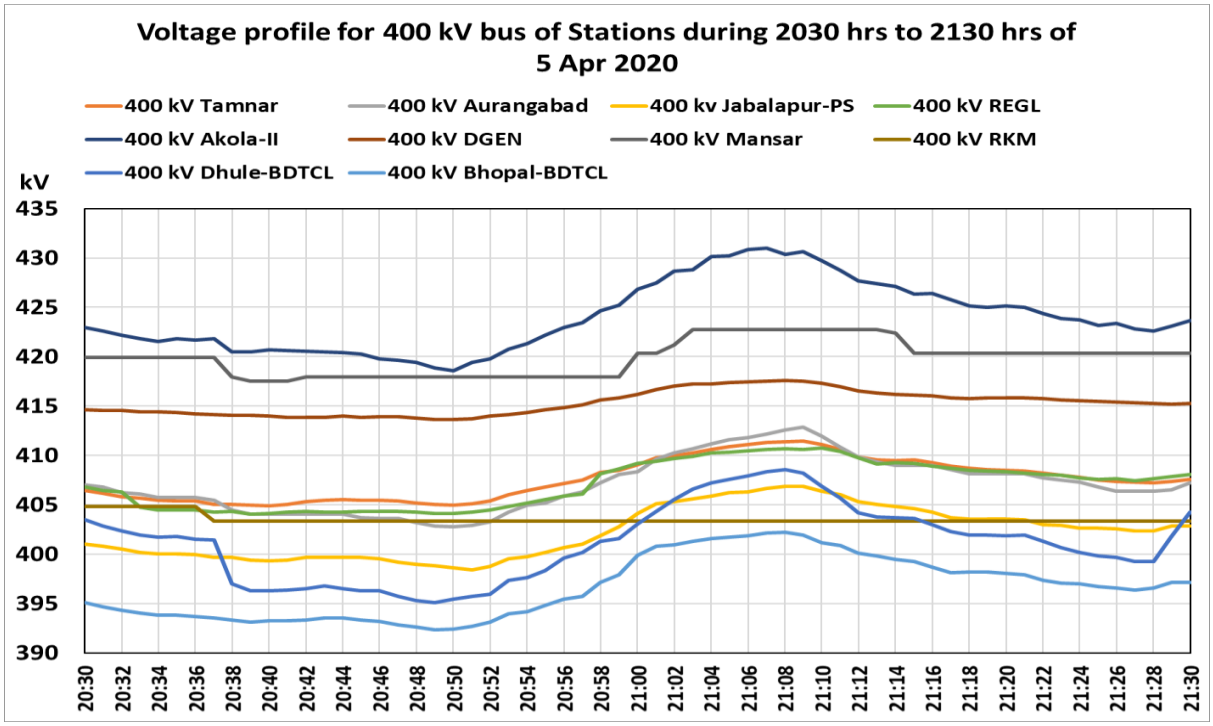
Voltage profile for 400 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
400 kV Tamnar
400 kV Aurangabad
400 kv Jabalapur-PS
400 kV REGL
400 kV Akola-II
400 kV DGEN
400 kV Mansar
400 kV RKM
400 kV Dhule-BDTCL
400 kV Bhopal-BDTCL
kV
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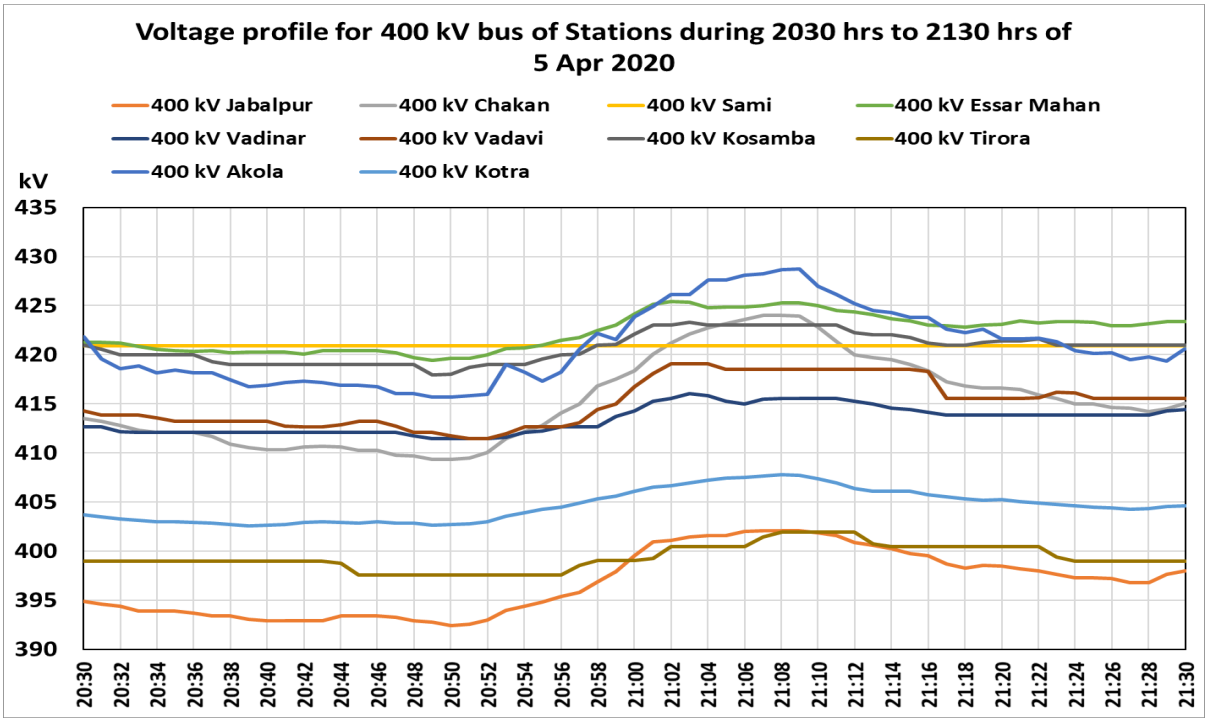
Voltage profile for 400 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
400 kV Jabalpur
400 kV Chakan
400 kV Sami
400 kV Essar Mahan
400 kV Vadinar
400 kV Vadavi
400 kV Kosamba
400 kV Tirora
400 kV Akola
400 kV Kotra
kV
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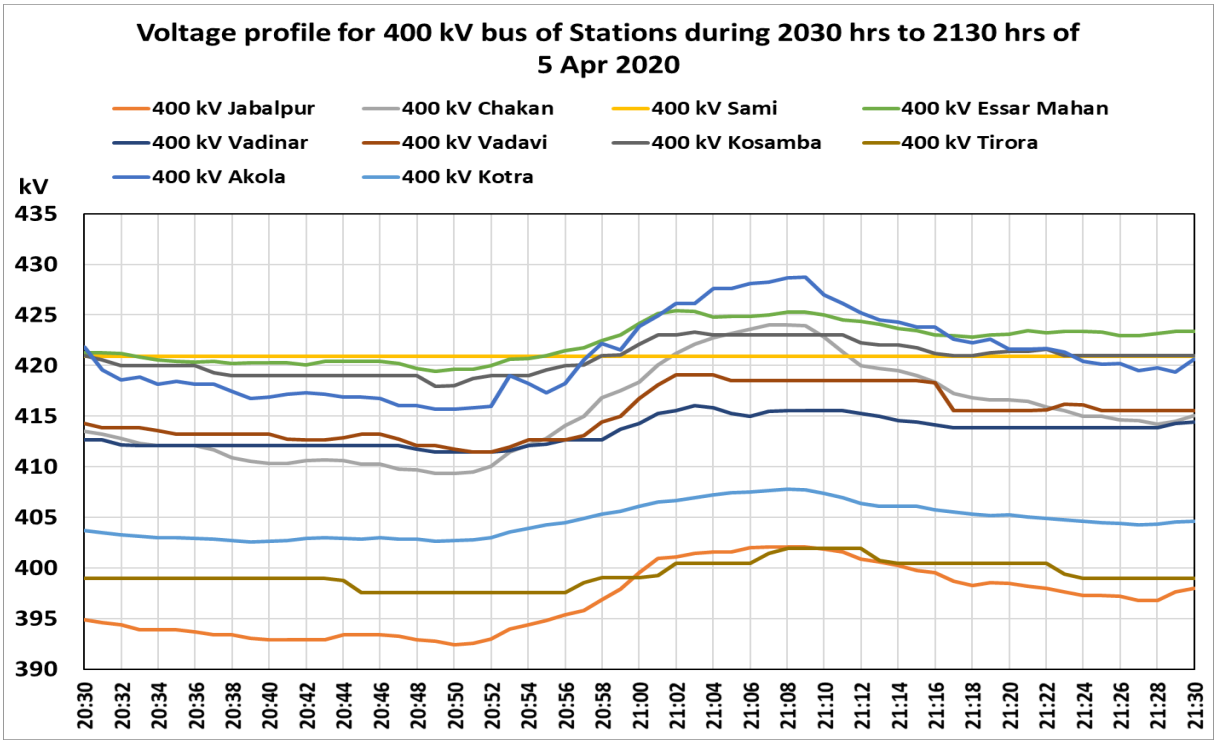
Voltage profile for 400 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
400 kV Jabalpur
400 kV Chakan
400 kV Sami
400 kV Essar Mahan
400 kV Vadinar
400 kV Vadavi
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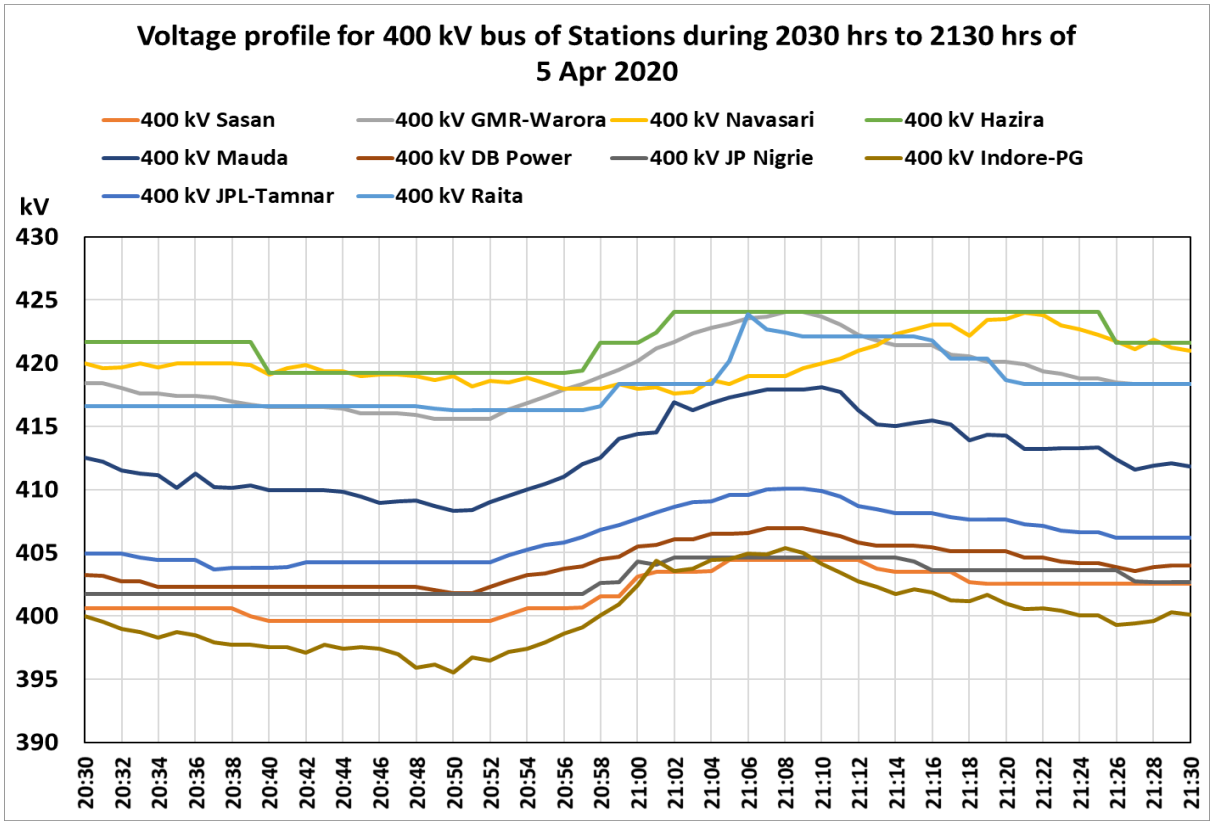
Voltage profile for 400 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
400 kV Sasan
400 kV GMR-Warora
400 kV Navasari
400 kV Hazira
400 kV Mauda
400 kV DB Power
400 kV JP Nigrie
400 kV Indore-PG
400 kV JPL-Tamnar
400 kV Raita
kV
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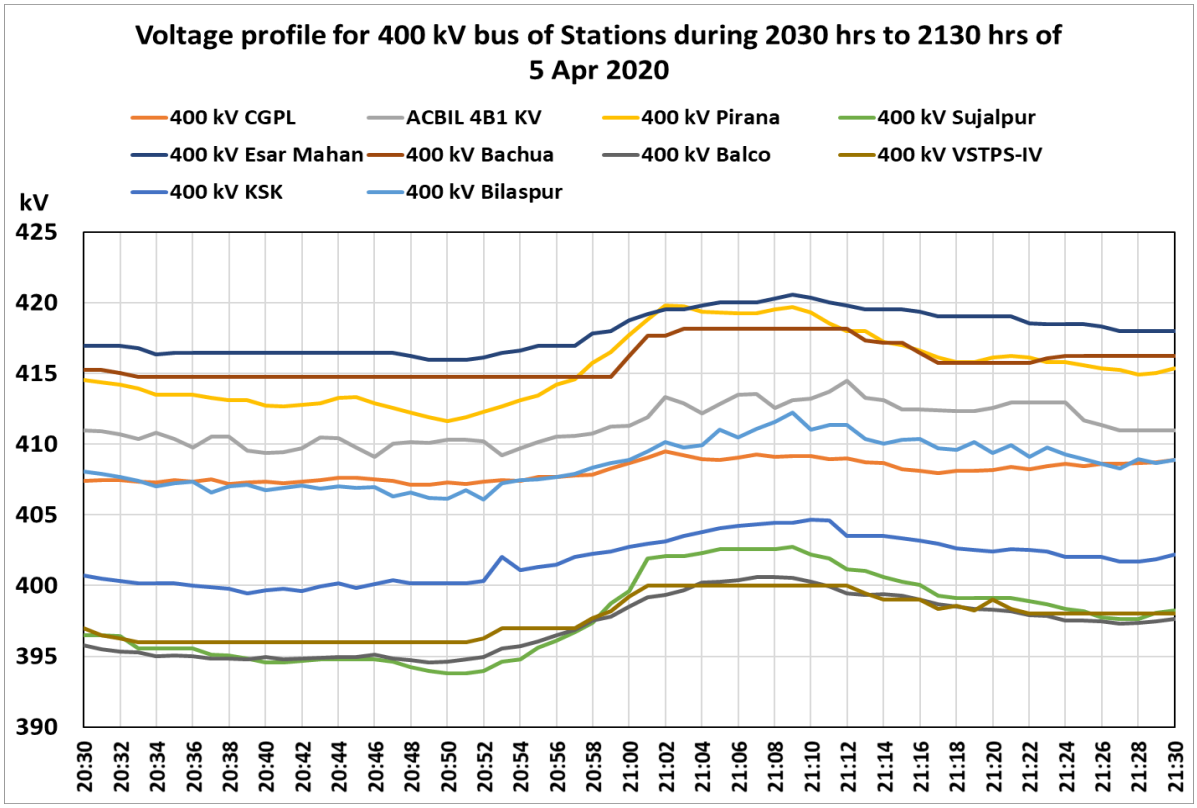
Voltage profile for 400 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
400 kV CGPL
ACBIL 4B1 KV
400 kV Pirana
400 kV Sujalpur
400 kV Esar Mahan
400 kV Bachua
400 kV Balco
400 kV VSTPS-IV
400 kV KSK
400 kV Bilaspur
kV
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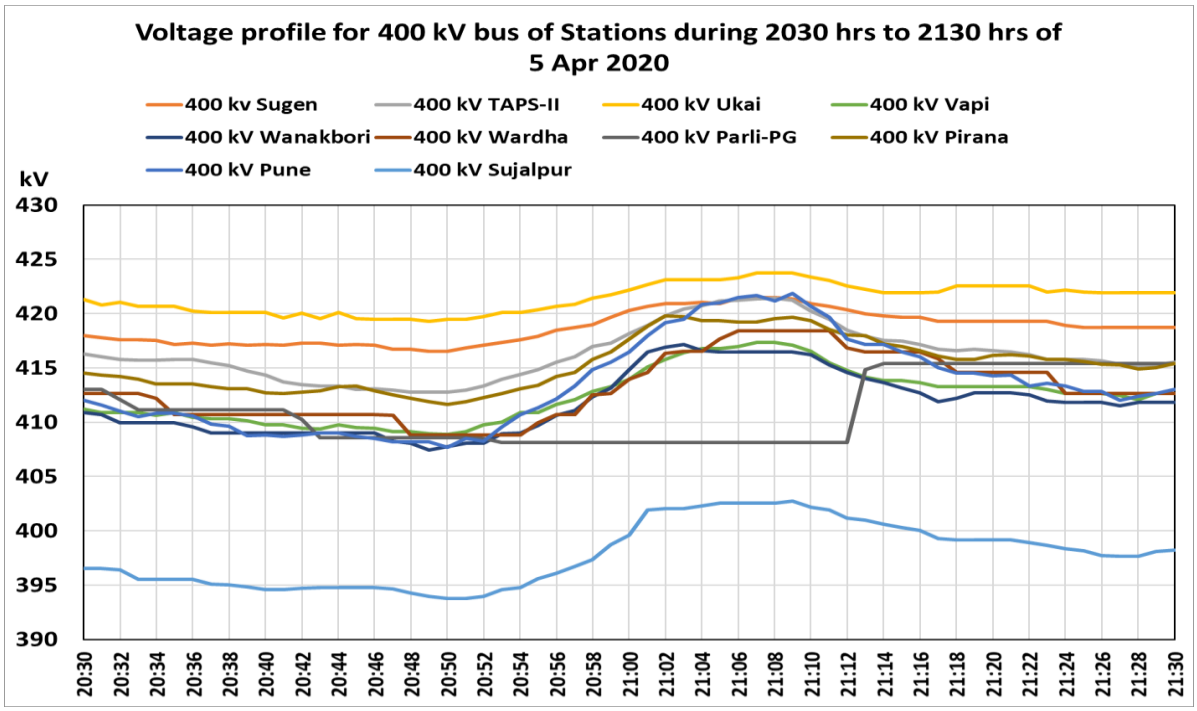
Voltage profile for 400 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
400 kv Sugen
400 kV TAPS-II
400 kV Ukai
400 kV Vapi
400 kV Wanakbori
400 kV Wardha
400 kV Parli-PG
400 kV Pirana
400 kV Pune
400 kV Sujalpur
kV
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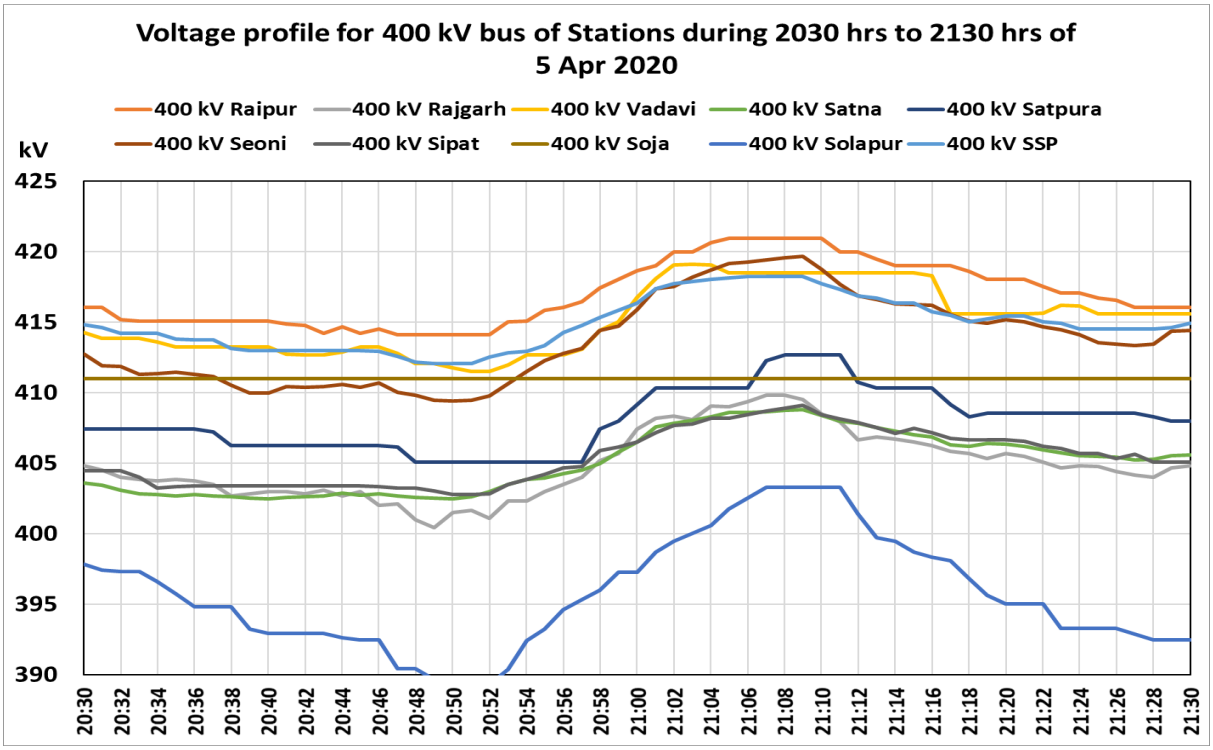
Voltage profile for 400 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
400 kV Raipur
400 kV Rajgarh
400 kV Vadavi
400 kV Satna
400 kV Satpura
400 kV Seoni
400 kV Sipat
400 kV Soja
400 kV Solapur
400 kV SSP
kV
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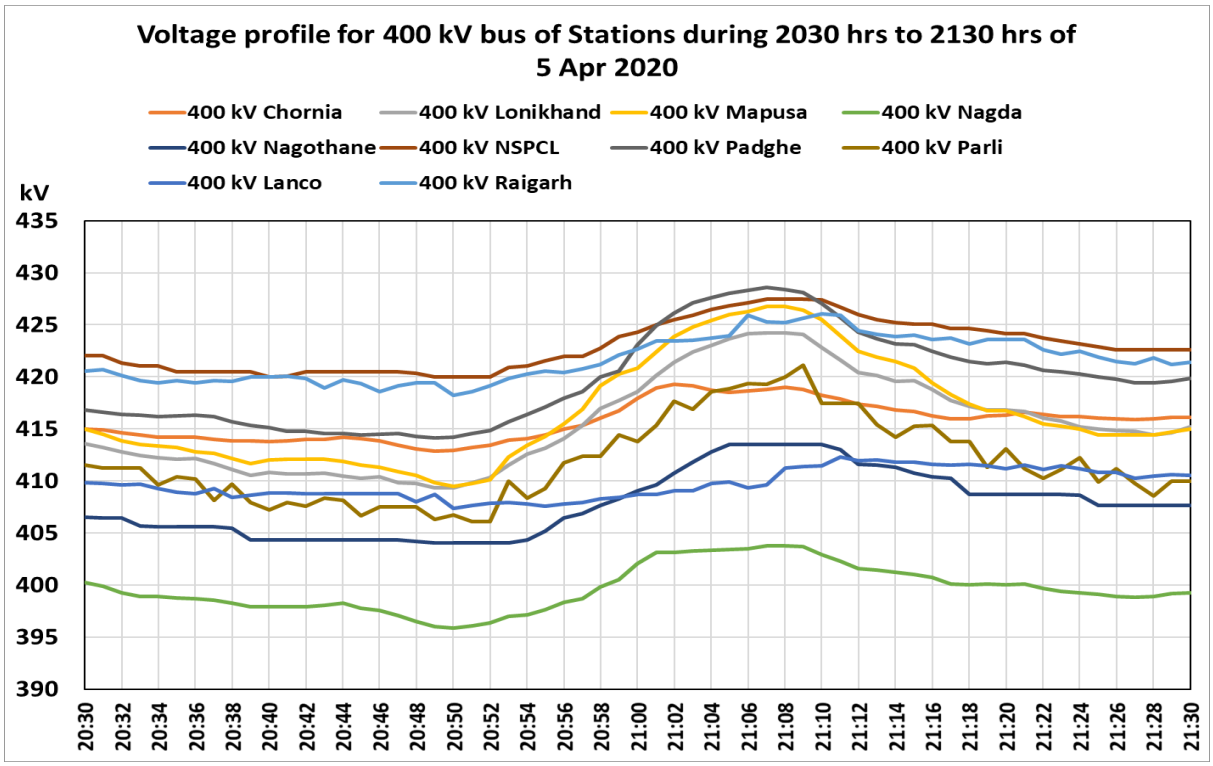
Voltage profile for 400 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
400 kV Chornia
400 kV Lonikhand
400 kV Mapusa
400 kV Nagda
400 kV Nagothane
400 kV NSPCL
400 kV Padghe
400 kV Parli
400 kV Lanco
400 kV Raigarh
kV
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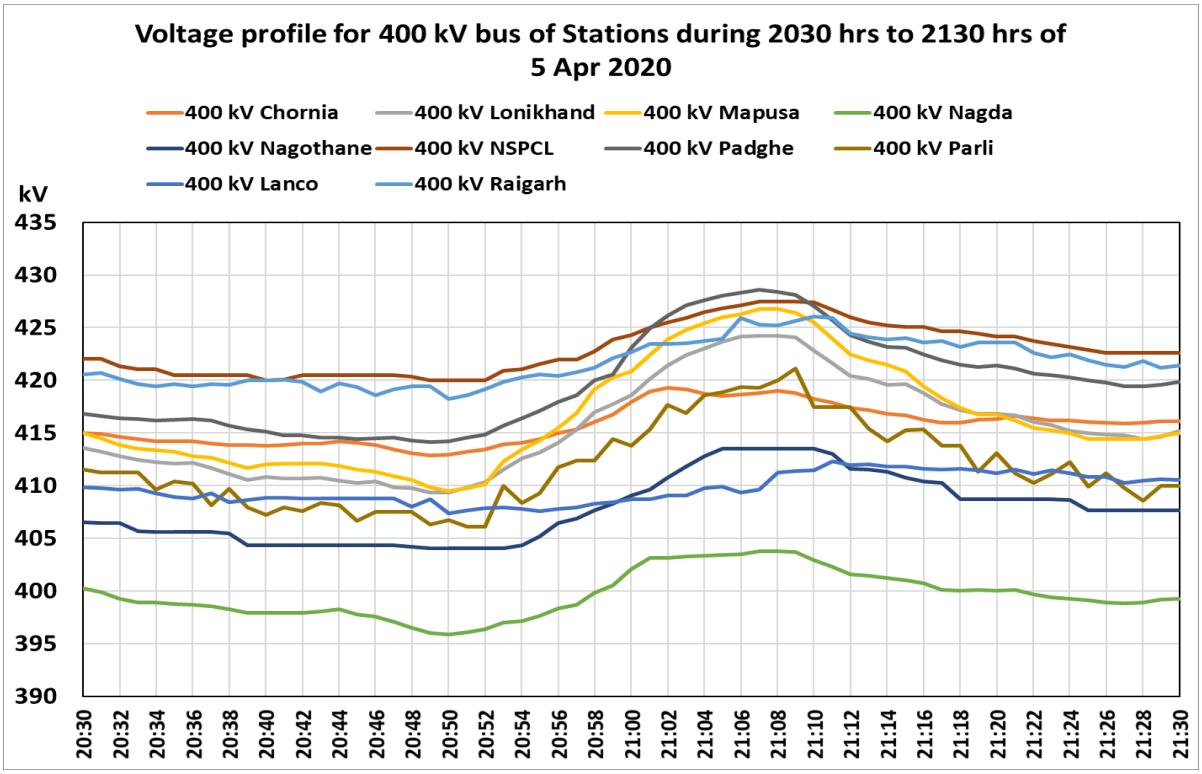
Voltage profile for 400 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
400 kV Chornia
400 kV Lonikhand
400 kV Mapusa
400 kV Nagda
400 kV Nagothane
400 kV NSPCL
400 kV Padghe
400 kV Parli
400 kV Lanco
400 kV Raigarh
kV
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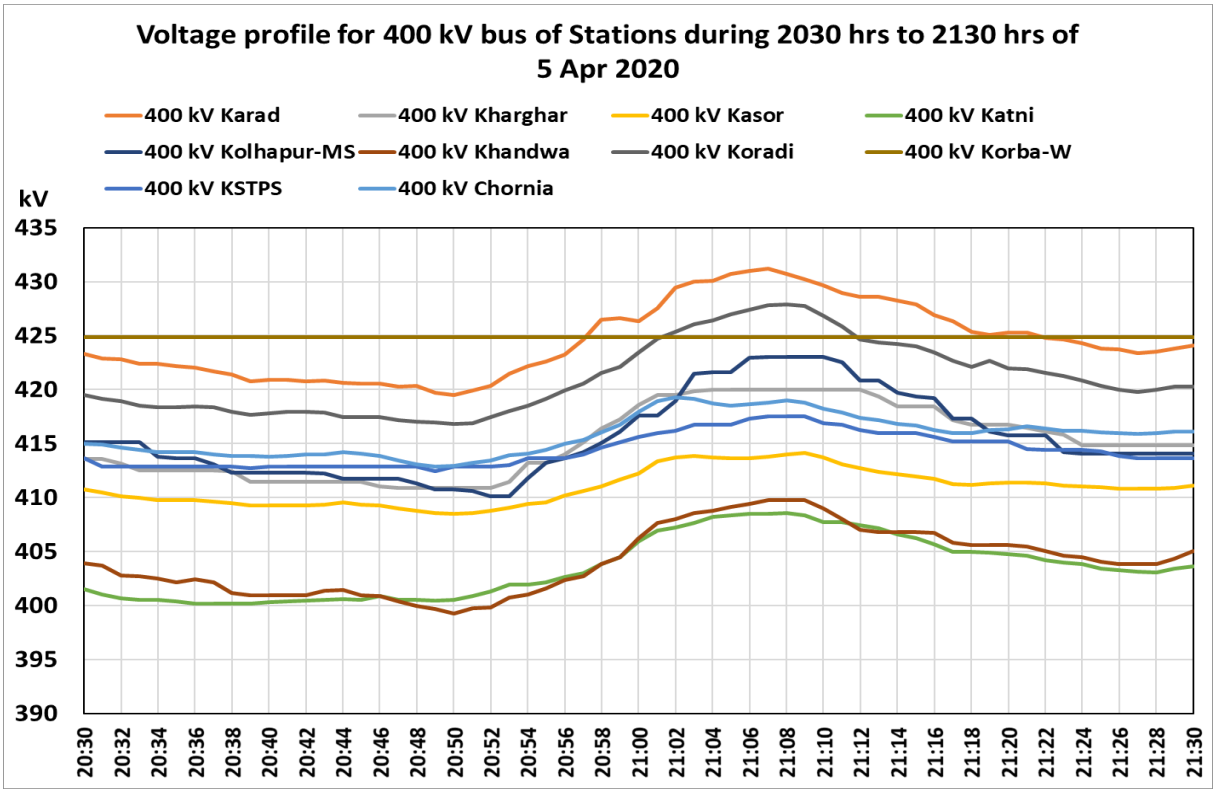
Voltage profile for 400 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
400 kV Karad
400 kV Kharghar
400 kV Kasor
400 kV Katni
400 kV Kolhapur-MS
400 kV Khandwa
400 kV Koradi
400 kV Korba-W
400 kV KSTPS
400 kV Chornia
kV
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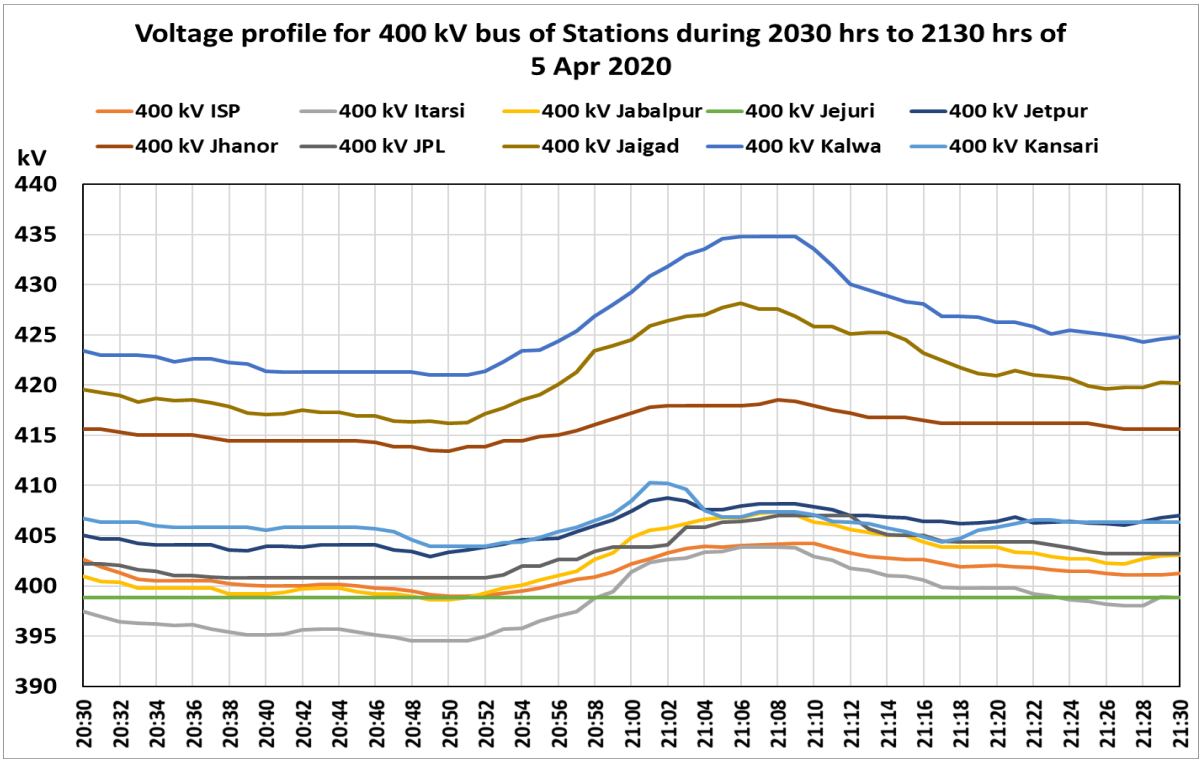
Voltage profile for 400 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
400 kV ISP
400 kV Itarsi
400 kV Jabalpur
400 kV Jejuri
400 kV Jetpur
400 kV Jhanor
400 kV JPL
400 kV Jaigad
400 kV Kalwa
400 kV Kansari
kV
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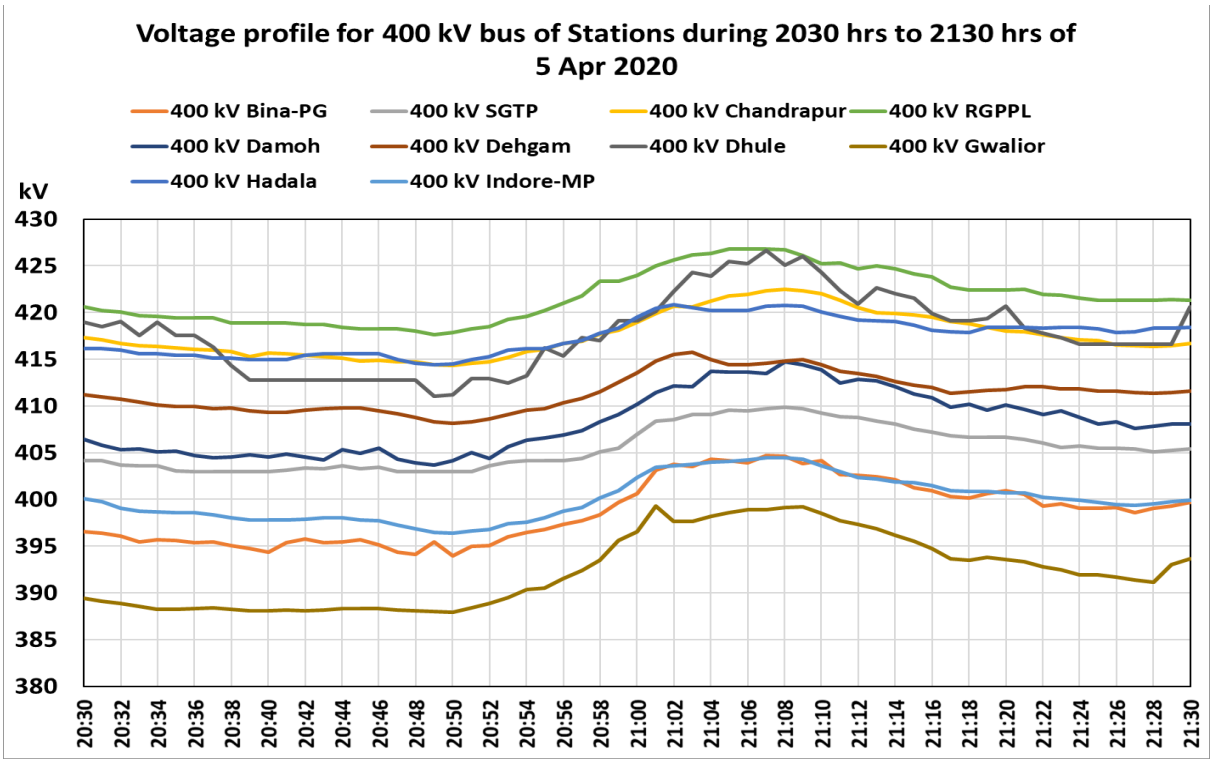
Voltage profile for 400 kV bus of Stations during 2030 hrs to 2130 hrs of 5 Apr 2020
400 kV Bina-PG
400 kV SGTP
400 kV Chandrapur
400 kV RGPPL
400 kV Damoh
400 kV Dehgam
400 kV Dhule
400 kV Gwalior
400 kV Hadala
400 kV Indore-MP
kV
430
425
420
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385
380
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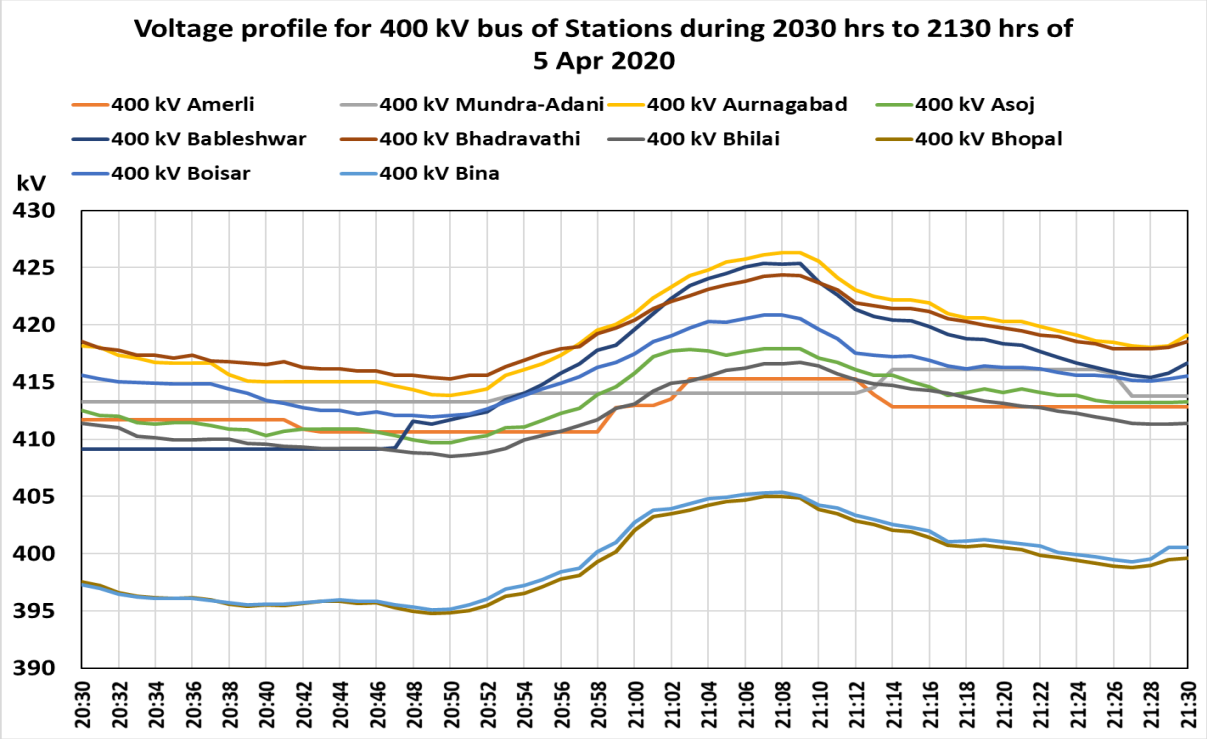
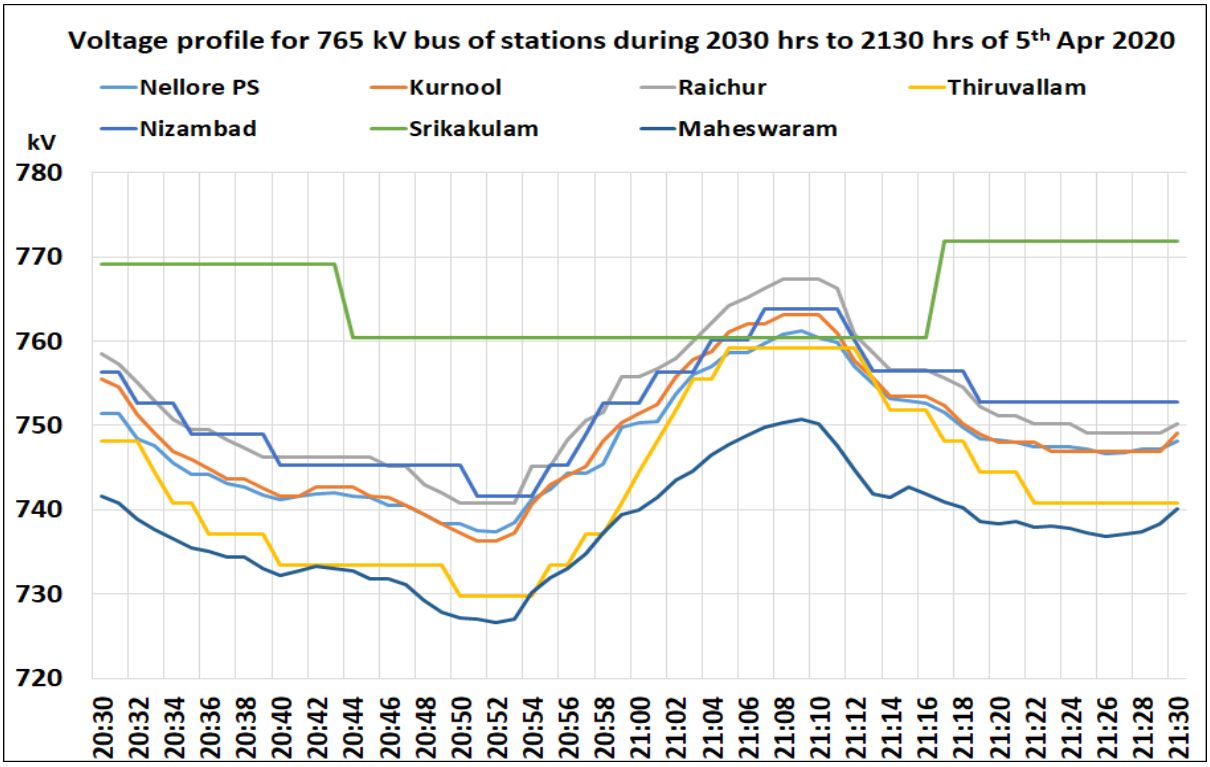
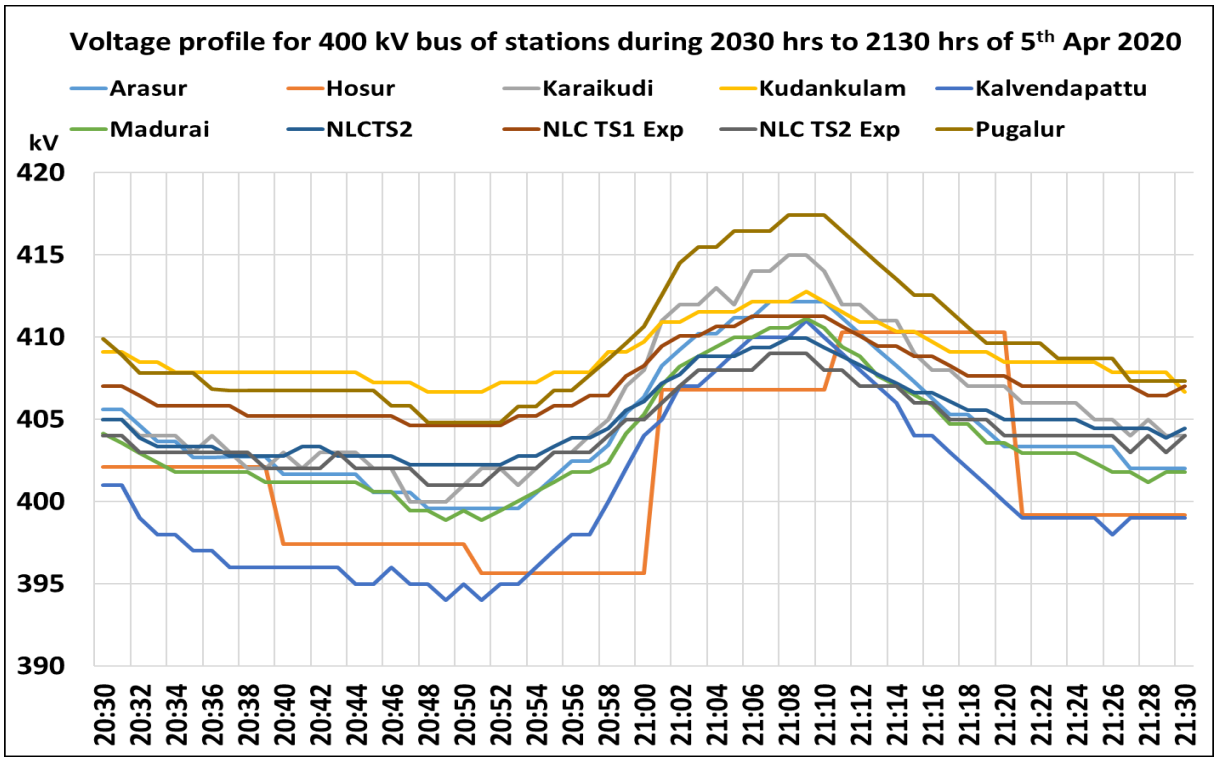


Southern Region




Voltage profile for 400 kV bus of stations during 2030 hrs to 2130 hrs of 5th Apr 2020
Arasur
Hosur
Karaikudi
Kudankulam
Kalvendapattu
Madurai
NLCTS2
NLC TS1 Exp
NLC TS2 Exp
Pugalur
kV
420
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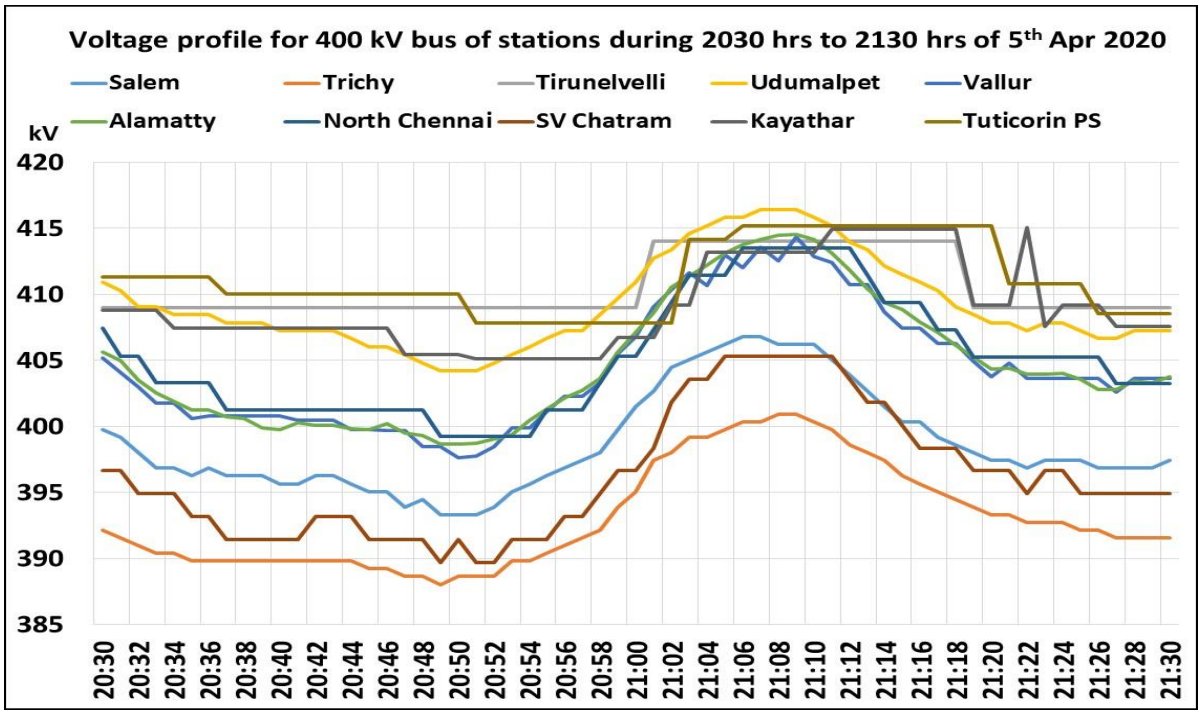
Voltage profile for 400 kV bus of stations during 2030 hrs to 2130 hrs of 5th Apr 2020
Salem
Trichy
Tirunelvelli
Udumalpet
Vallur
Alamatty
North Chennai
SV Chatram
Kayathar
Tuticorin PS
kV
420
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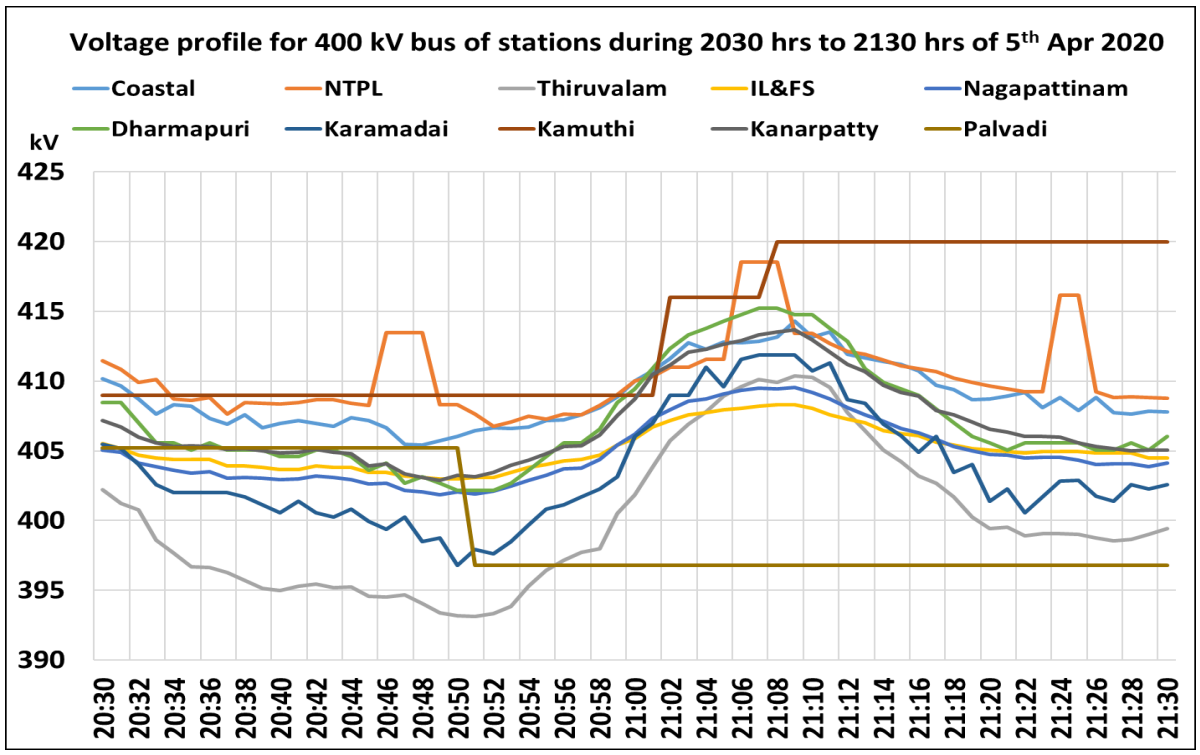
Voltage profile for 400 kV bus of stations during 2030 hrs to 2130 hrs of 5th Apr 2020
Coastal
NTPL
Thiruvalam
IL&FS
Nagapattinam
Dharmapuri
Karamadai
Kamuthi
Kanarpatty
Palvadi
kV
425
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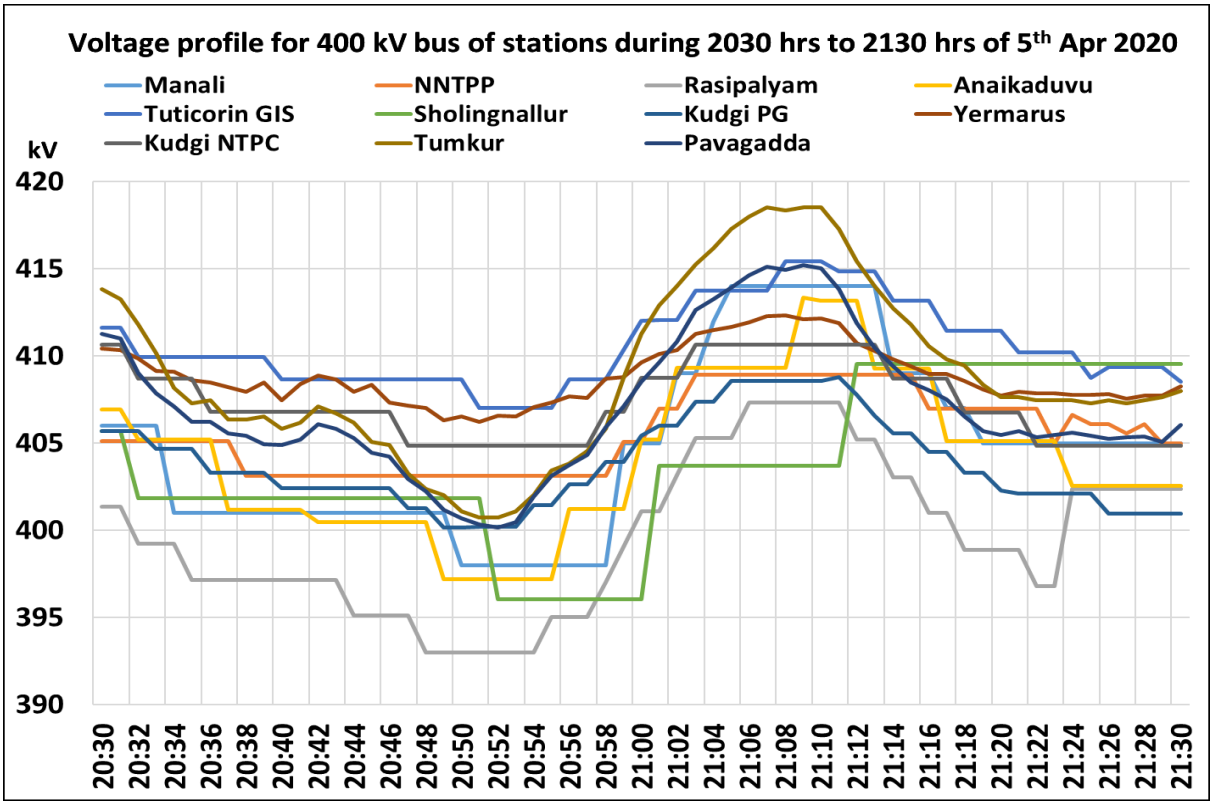
Voltage profile for 400 kV bus of stations during 2030 hrs to 2130 hrs of 5th Apr 2020
Manali
NNTPP
Rasipalyam
Anaikaduvu
Tuticorin GIS
Sholingnallur
Kudgi PG
Yermarus
Kudgi NTPC
Tumkur
Pavagadda
kV
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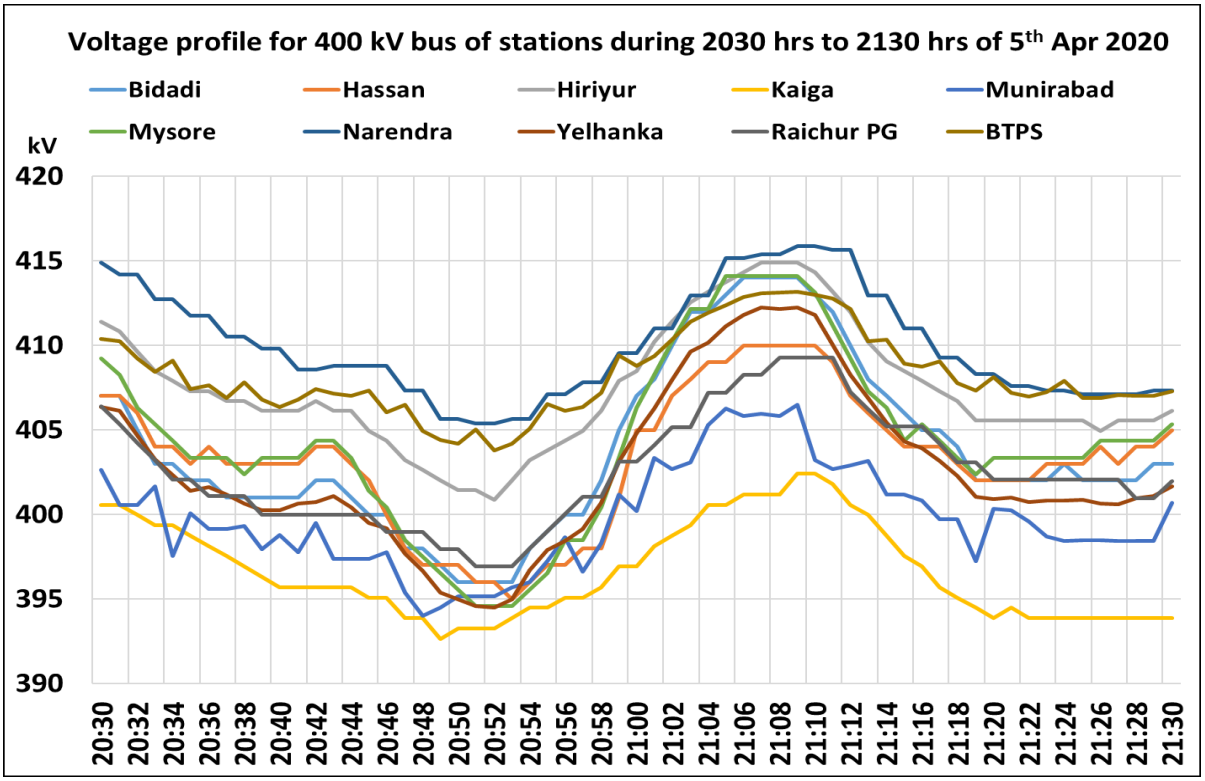
Voltage profile for 400 kV bus of stations during 2030 hrs to 2130 hrs of 5th Apr 2020
Bidadi
Hassan
Hiriyur
Kaiga
Munirabad
Mysore
Narendra
Yelhanka
Raichur PG
BTPS
kV
420
415
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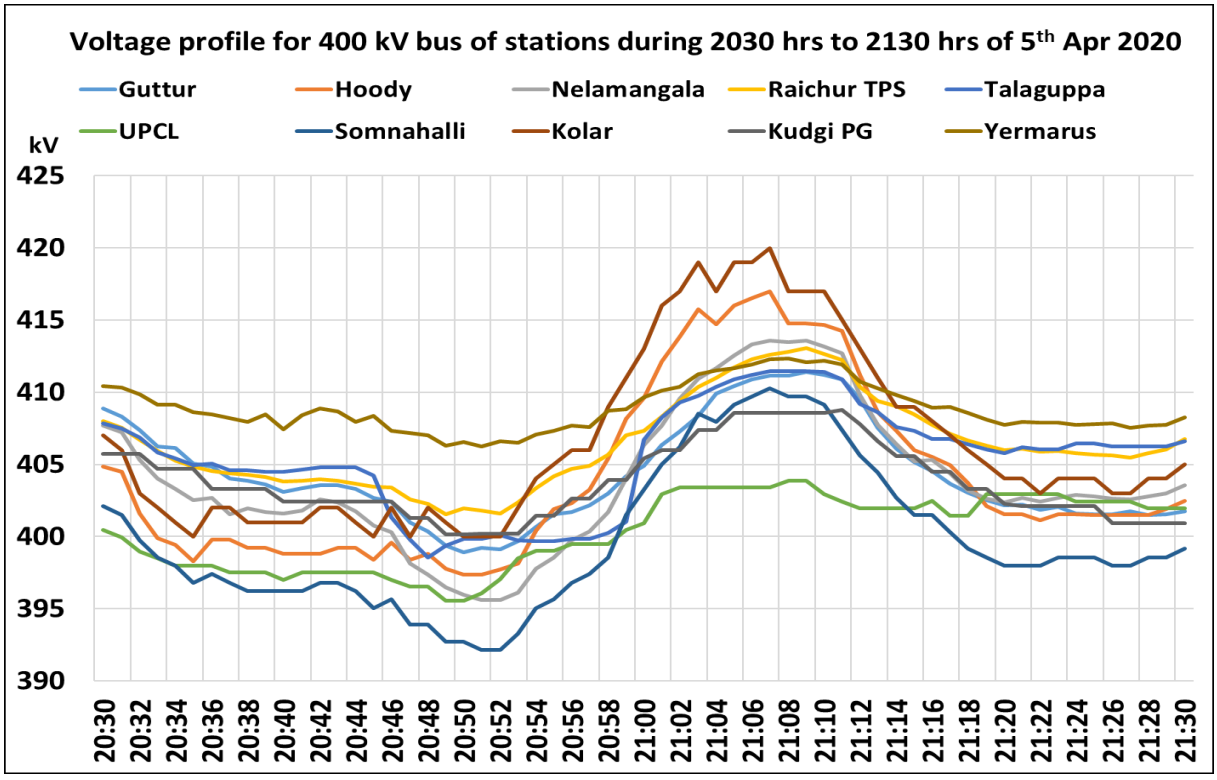
Voltage profile for 400 kV bus of stations during 2030 hrs to 2130 hrs of 5th Apr 2020
Guttur
Hoody
Nelamangala
Raichur TPS
Talaguppa
UPCL
Somnahalli
Kolar
Kudgi PG
Yermarus
kV
425
420
415
410
405
400
395
390
20:30
20:32
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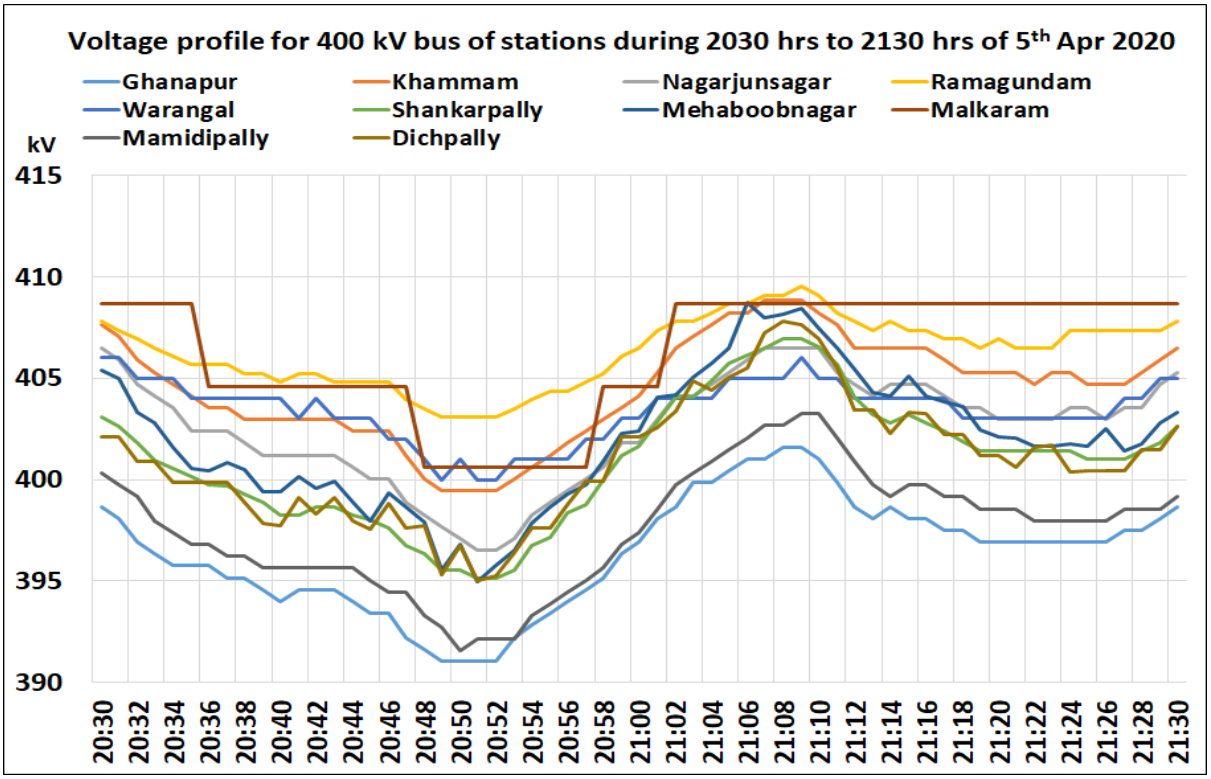
Voltage profile for 400 kV bus of stations during 2030 hrs to 2130 hrs of 5th Apr 2020
Ghanapur
Khammam
Nagarjunsagar
Ramagundam
Warangal
Shankarpally
Mehaboobnagar
Malkaram
Mamidipally
Dichpally
kV
415
410
405
400
395
390
20:30
20:32
20:34
20:36
20:38
20:40
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20:46
20:48
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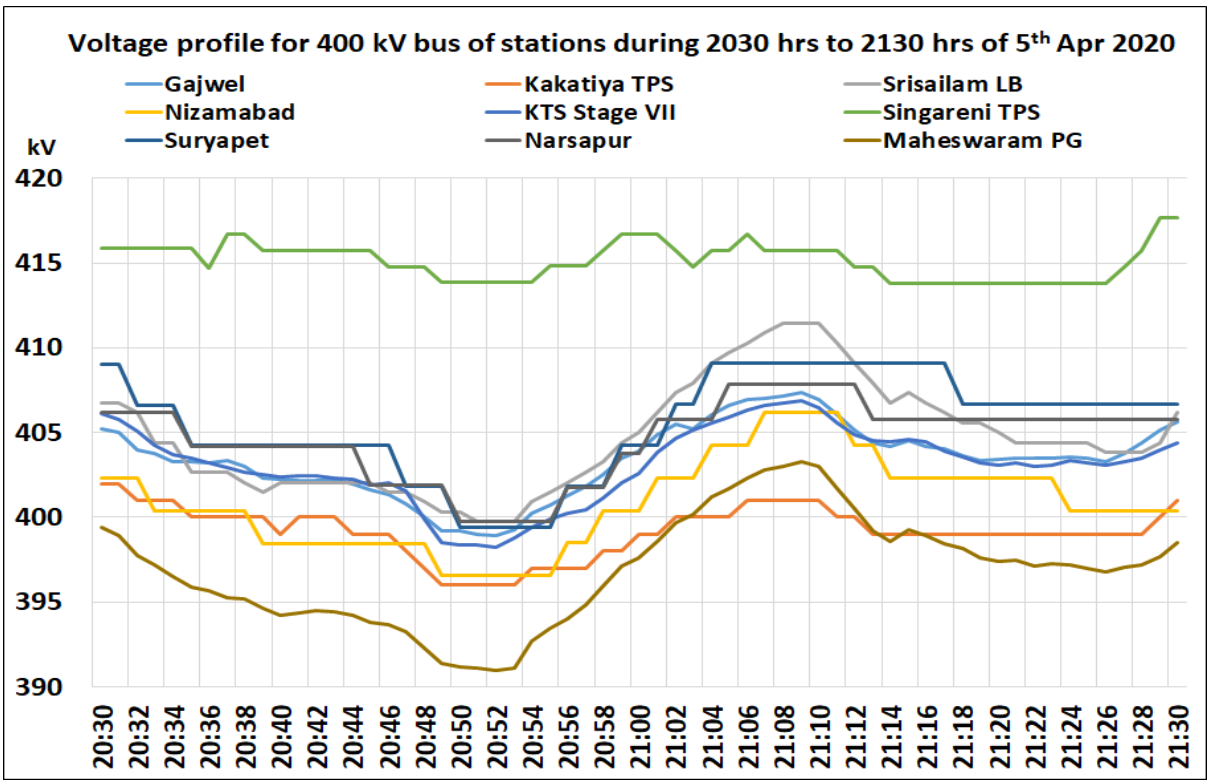
Voltage profile for 400 kV bus of stations during 2030 hrs to 2130 hrs of 5th Apr 2020
Gajwel
Kakatiya TPS
Srisailam LB
Nizamabad
KTS Stage VII
Singareni TPS
Suryapet
Narsapur
Maheswaram PG
kV
420
415
410
405
400
395
390
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
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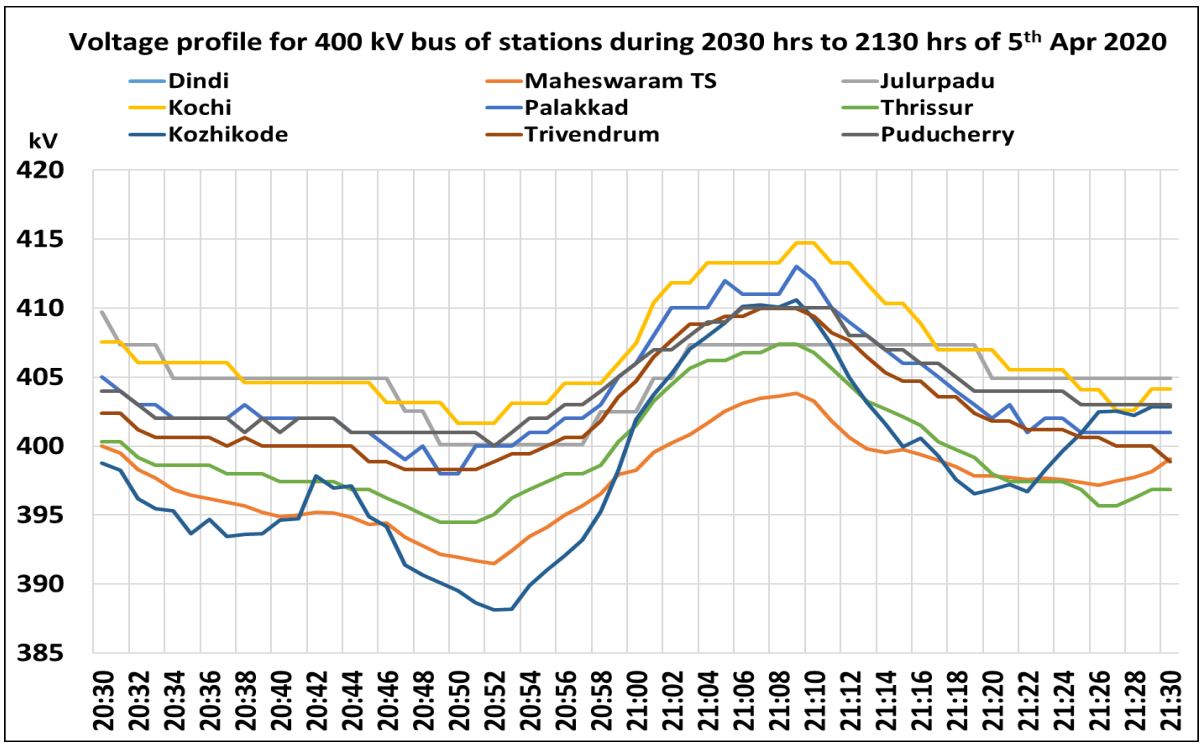
Voltage profile for 400 kV bus of stations during 2030 hrs to 2130 hrs of 5th Apr 2020
Dindi
Maheswaram TS
Julurpadu
Kochi
Palakkad
Thrissur
Kozhikode
Trivendrum
Puducherry
kV
420
415
410
405
400
395
390
385
20:30
20:32
20:34
20:36
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20:42
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21:28
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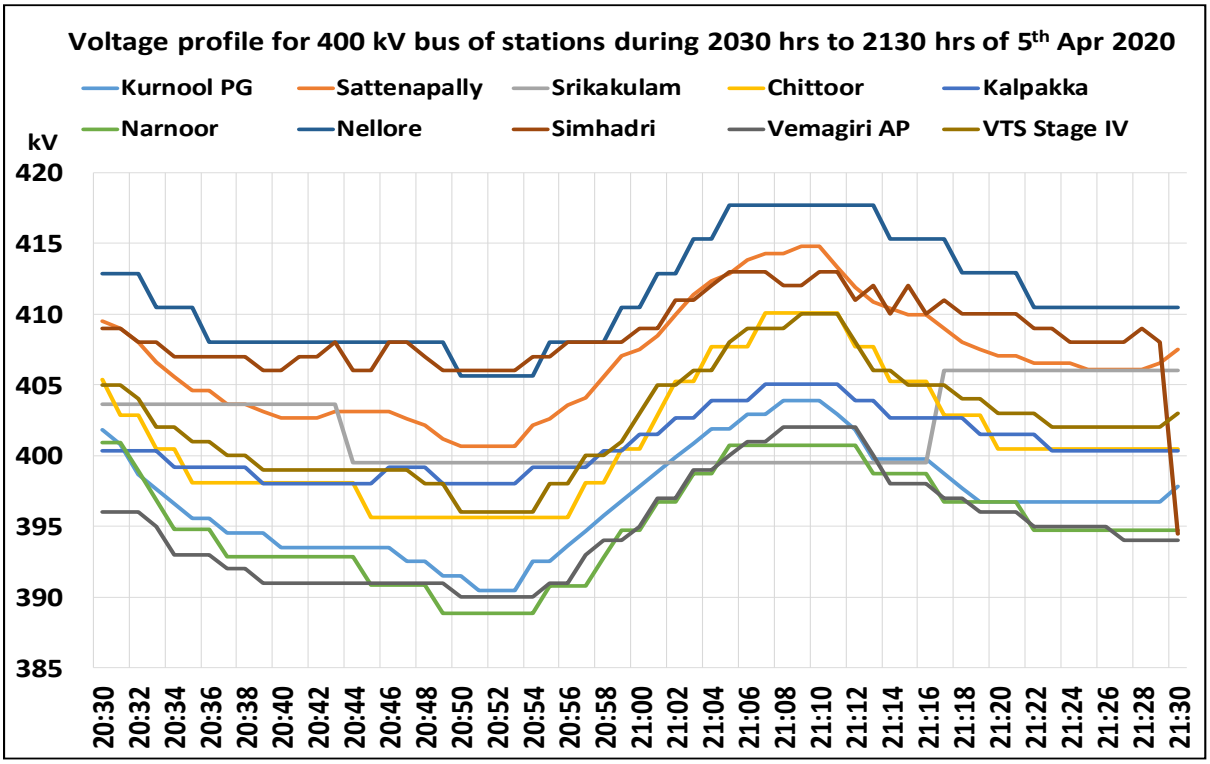
Voltage profile for 400 kV bus of stations during 2030 hrs to 2130 hrs of 5th Apr 2020
Kurnool PG
Sattenapally
Srikakulam
Chittoor
Kalpakka
Narnoor
Nellore
Simhadri
Vemagiri AP
VTS Stage IV
kV
420
415
410
405
400
395
390
385
20:30
20:32
20:34
20:36
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20:40
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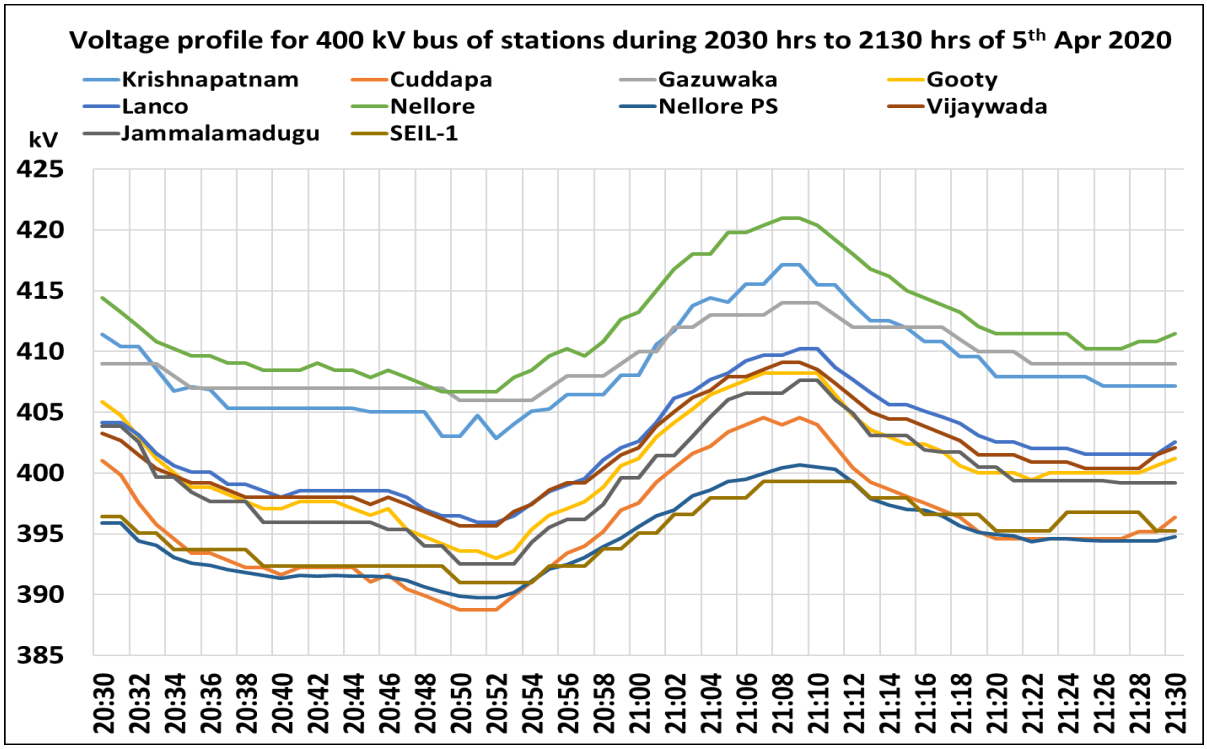
Voltage profile for 400 kV bus of stations during 2030 hrs to 2130 hrs of 5th Apr 2020
Krishnapatnam
Cuddapa
Gazuwaka
Gooty
Lanco
Nellore
Nellore PS
Vijaywada
Jammalamadugu
SEIL-1
kV
425
420
415
410
405
400
395
390
385
20:30
20:32
20:34
20:36
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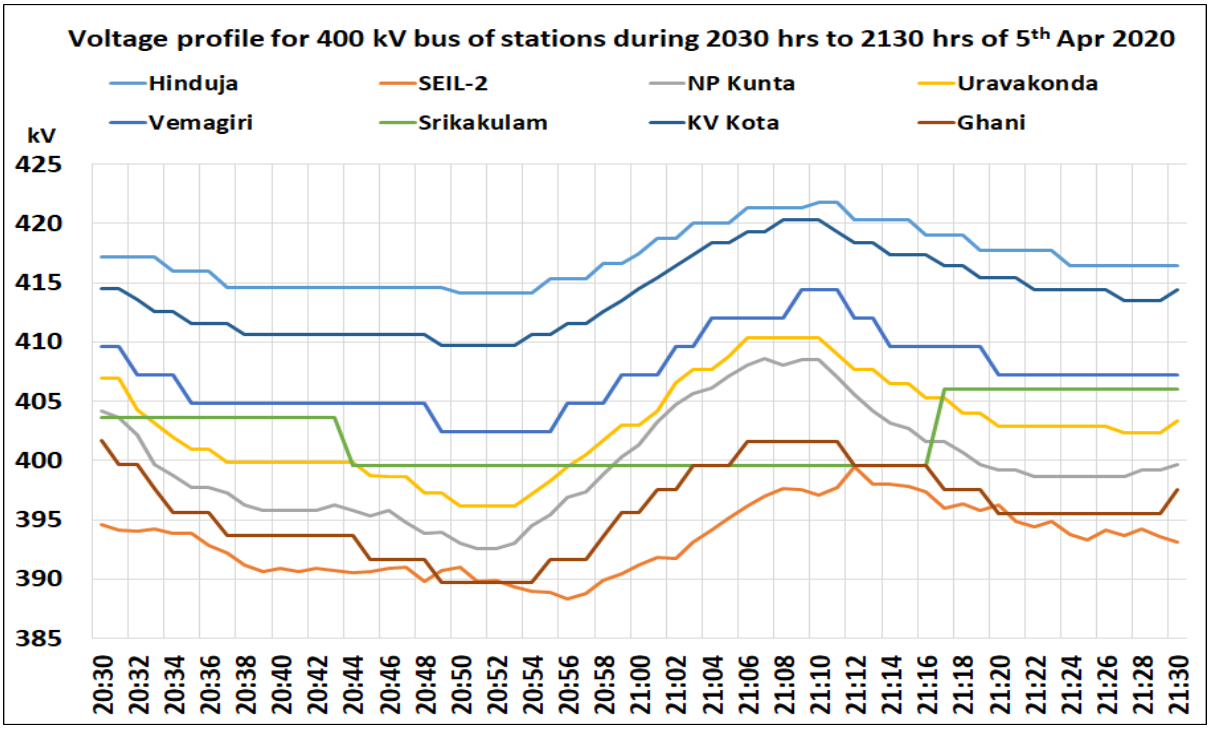
Voltage profile for 400 kV bus of stations during 2030 hrs to 2130 hrs of 5th Apr 2020
Hinduja
SEIL-2
NP Kunta
Uravakonda
Vemagiri
Srikakulam
KV Kota
Ghani
kV
425
420
415
410
405
400
395
390
385
20:30
20:32
20:34
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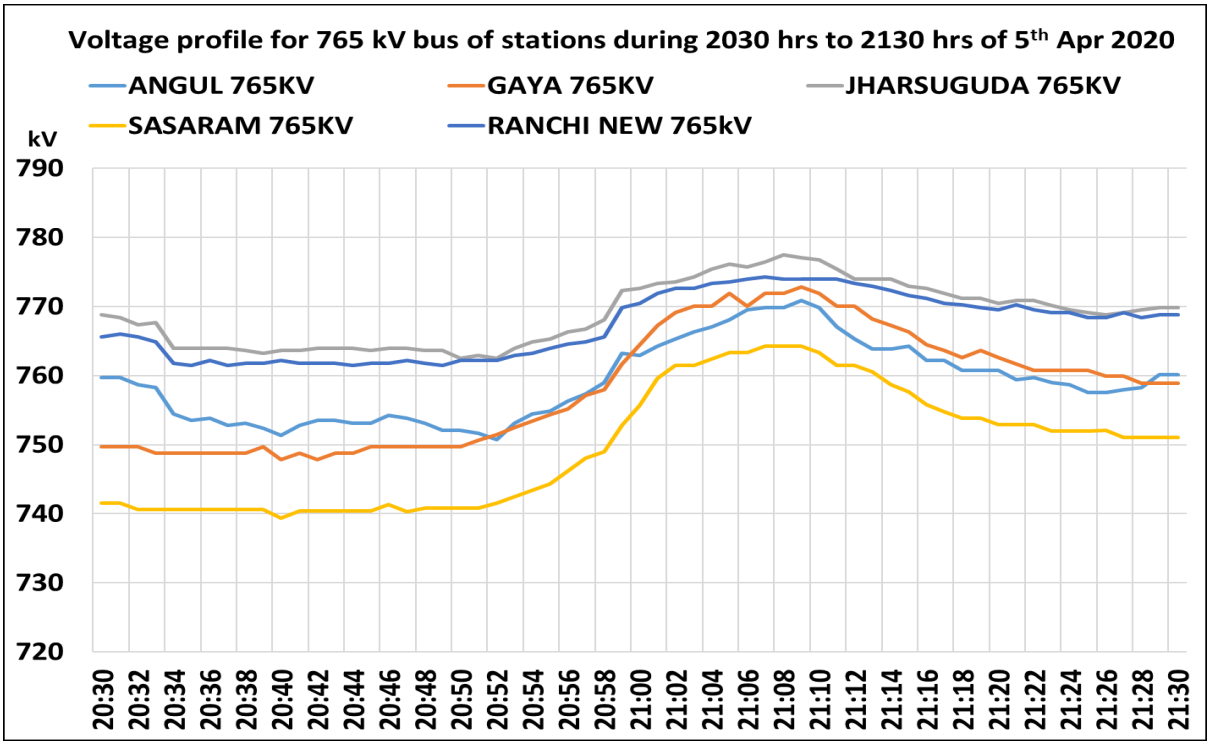
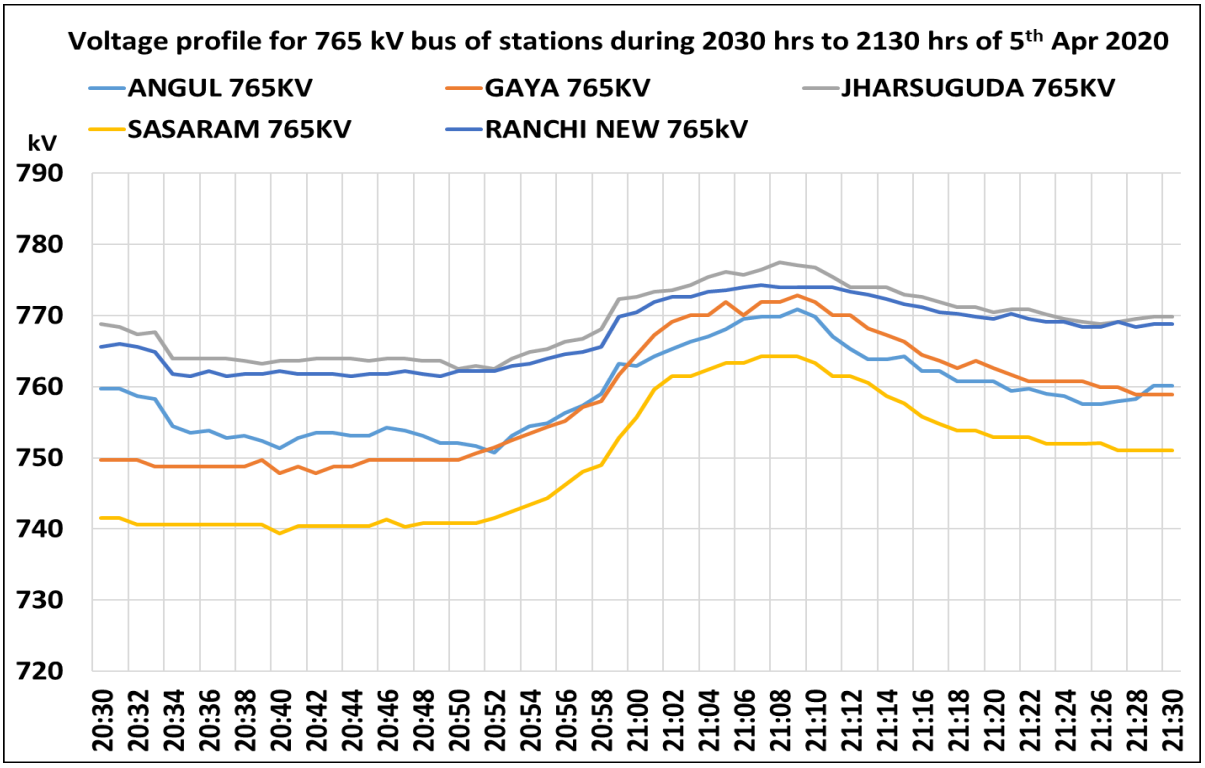
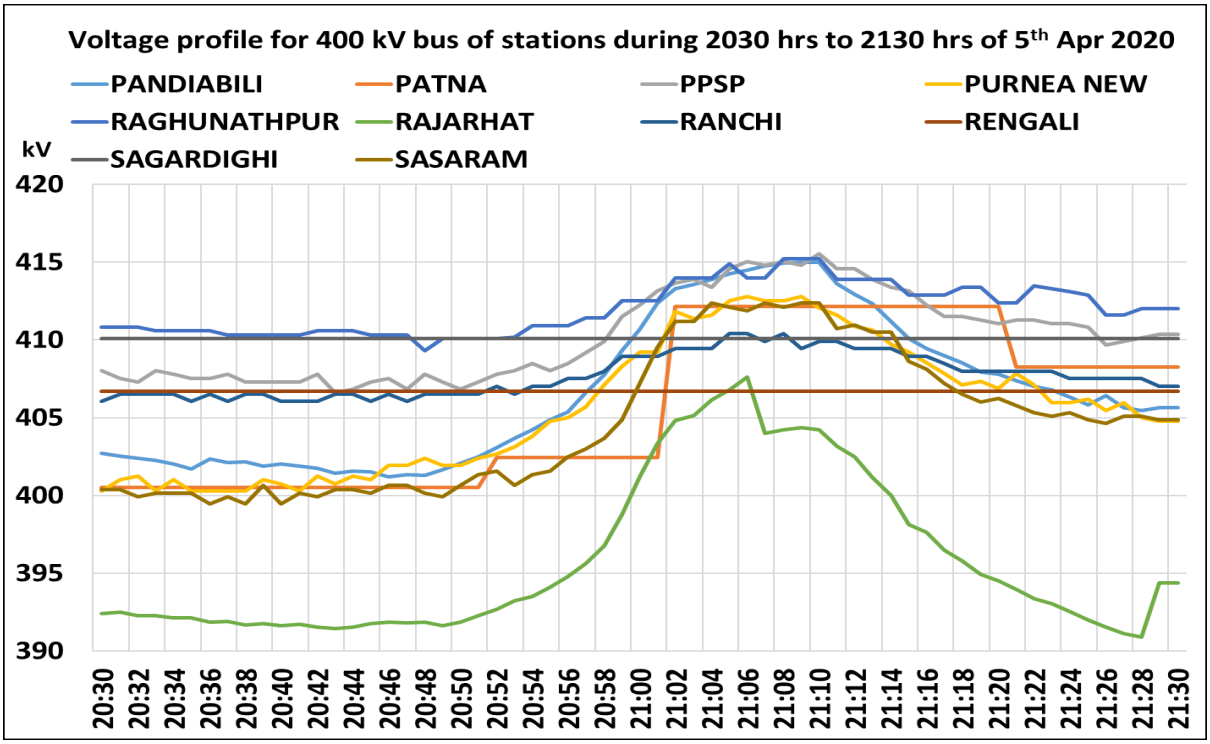
Eastern Region






Voltage profile for 400 kV bus of stations during 2030 hrs to 2130 hrs of 5th Apr 2020
PANDIABILI
PATNA
PPSP
PURNEA NEW
RAGHUNATHPUR
RAJARHAT
RANCHI
RENGALI
SAGARDIGHI
SASARAM
kV
420
415
410
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400
395
390
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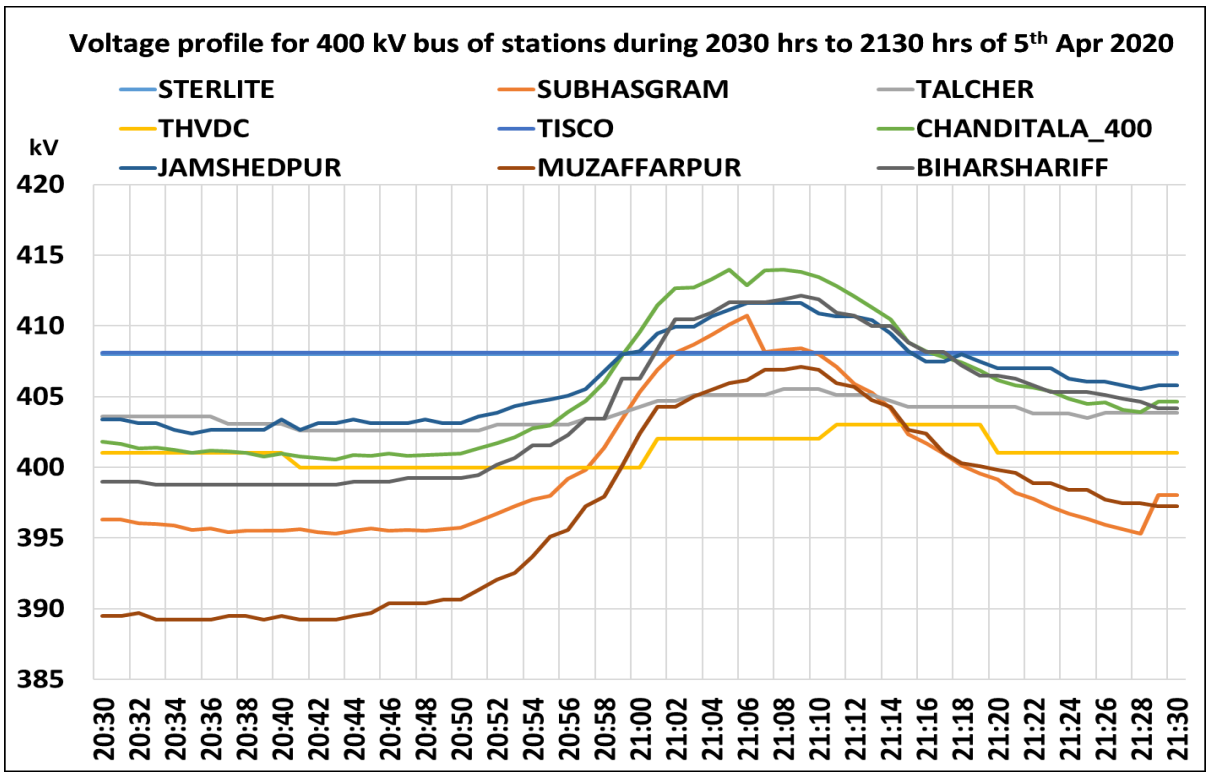
Voltage profile for 400 kV bus of stations during 2030 hrs to 2130 hrs of 5th Apr 2020
STERLITE
SUBHASGRAM
TALCHER
THVDC
TISCO
CHANDITALA_400
JAMSHEDPUR
MUZAFFARPUR
BIHARSHARIFF
kV
420
415
410
405
400
395
390
385
20:30
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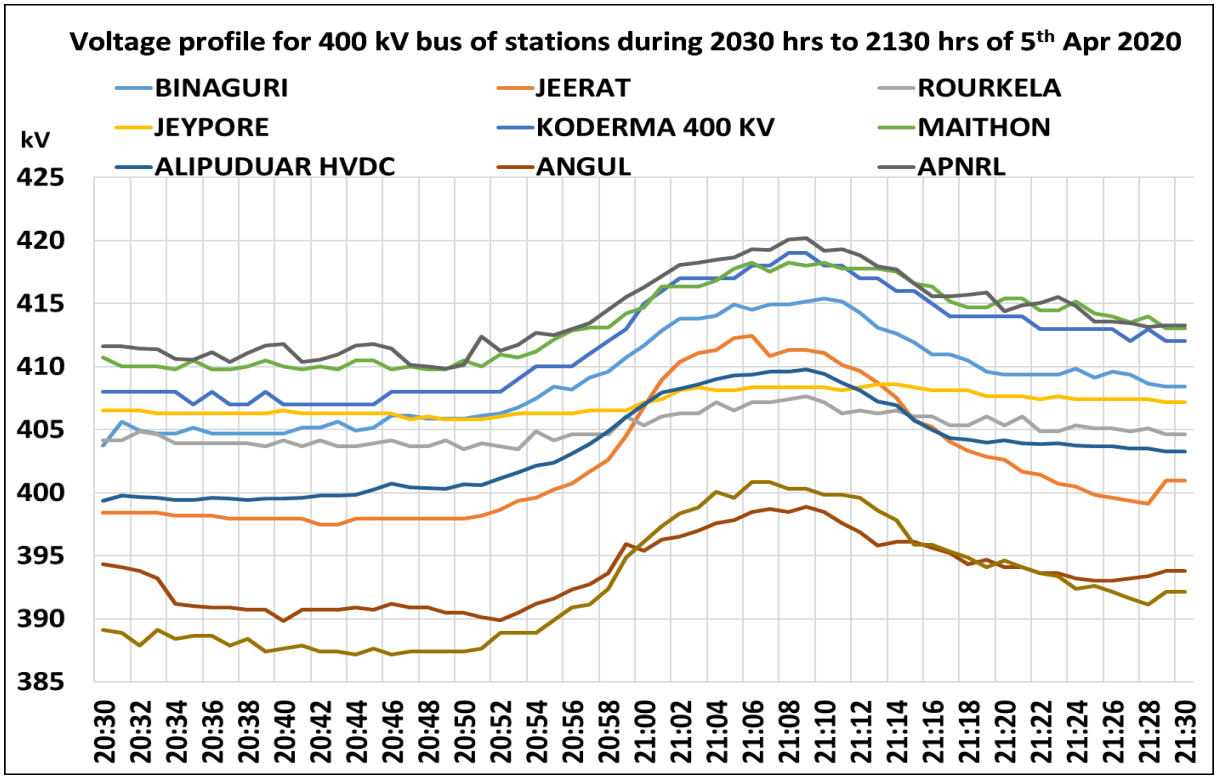
Voltage profile for 400 kV bus of stations during 2030 hrs to 2130 hrs of 5th Apr 2020
BINAGURI
JEERAT
ROURKELA
JEYPORE
KODERMA 400 KV
MAITHON
ALIPUDUAR HVDC
ANGUL
APNRL
kV
425
420
415
410
405
400
395
390
385
20:30
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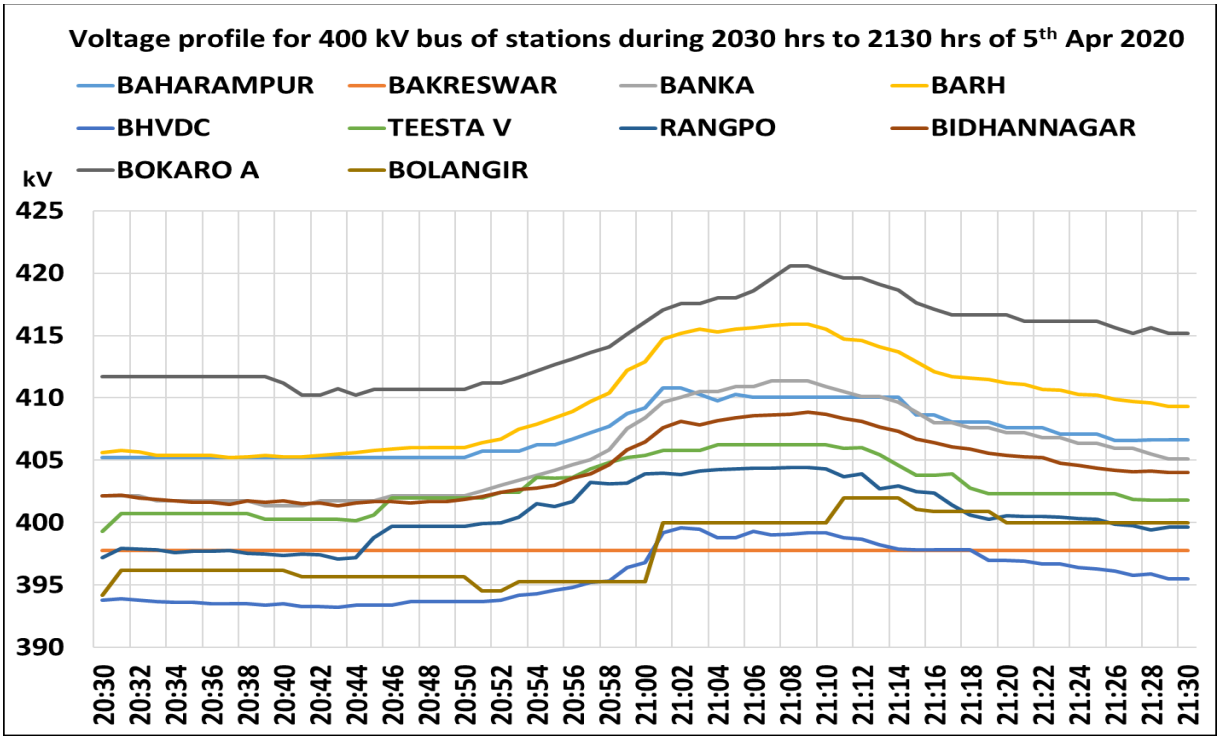
Voltage profile for 400 kV bus of stations during 2030 hrs to 2130 hrs of 5th Apr 2020
BAHARAMPUR
BAKRESWAR
BANKA
BARH
BHVDC
TEESTA V
RANGPO
BIDHANNAGAR
BOKARO A
BOLANGIR
kV
425
420
415
410
405
400
395
390
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
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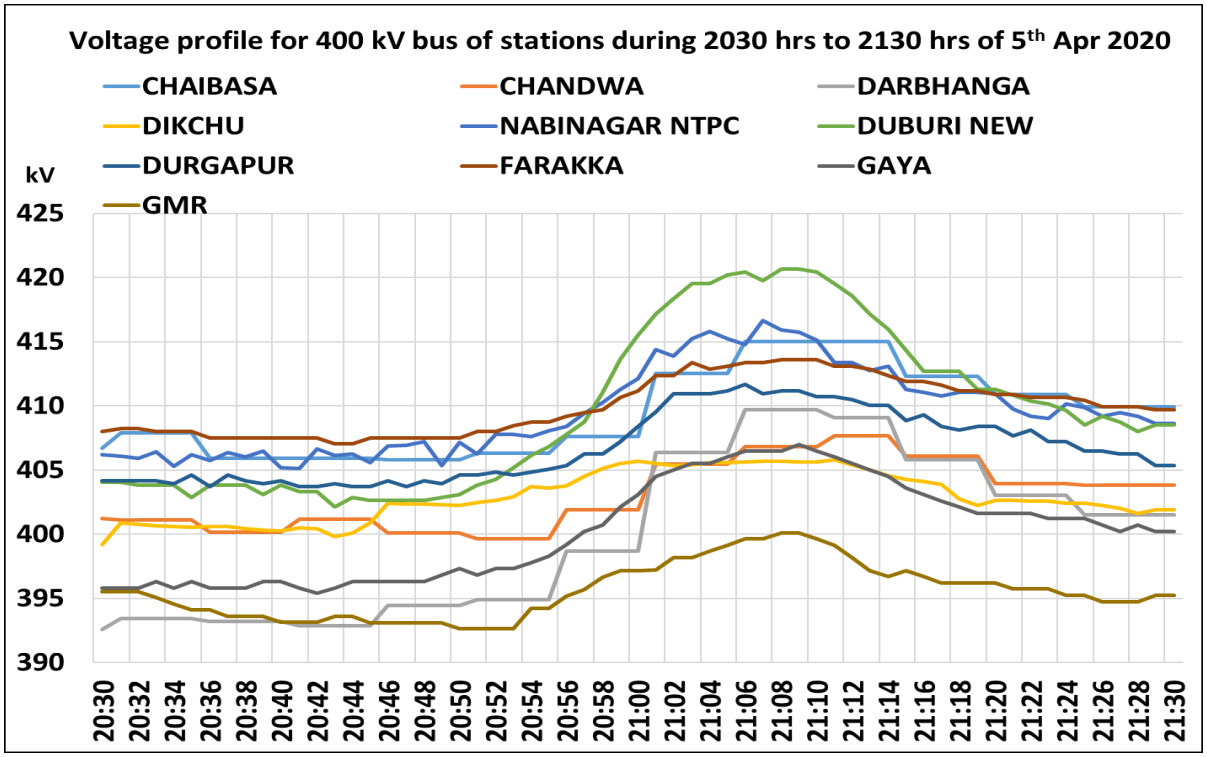
Voltage profile for 400 kV bus of stations during 2030 hrs to 2130 hrs of 5th Apr 2020
CHAIBASA
CHANDWA
DARBHANGA
DIKCHU
NABINAGAR NTPC
DUBURI NEW
DURGAPUR
FARAKKA
GAYA
GMR
kV
425
420
415
410
405
400
395
390
20:30
20:32
20:34
20:36
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20:40
20:42
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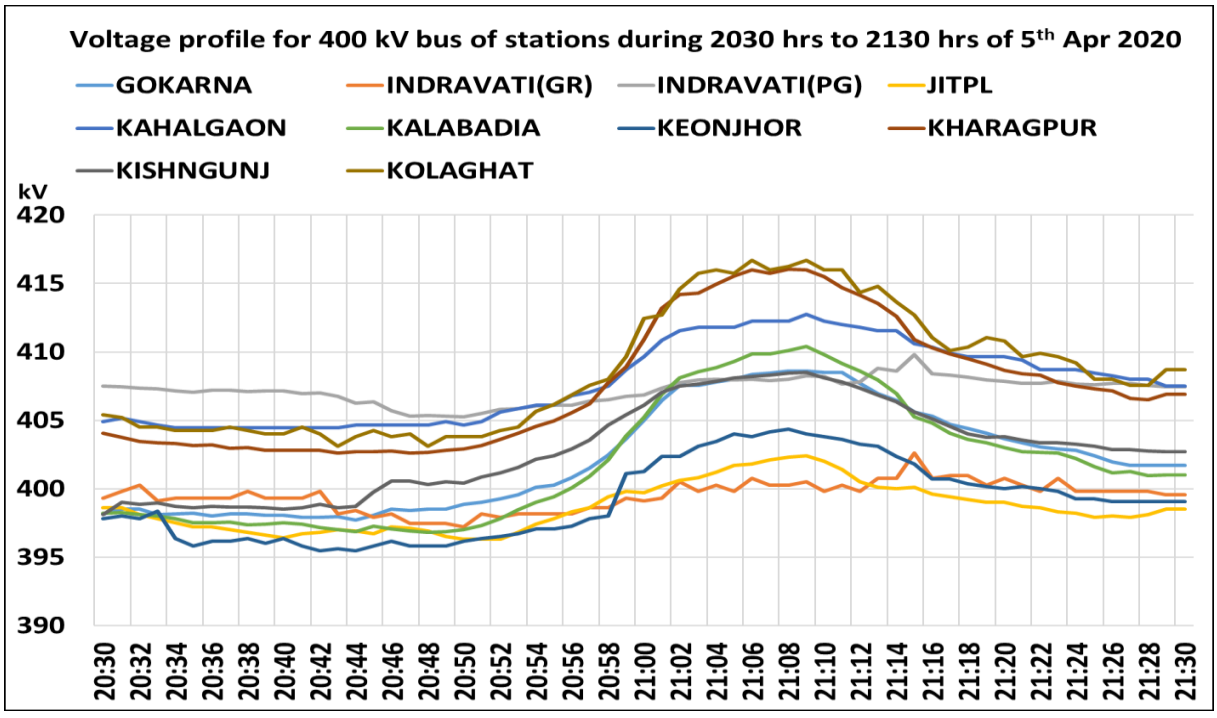
Voltage profile for 400 kV bus of stations during 2030 hrs to 2130 hrs of 5th Apr 2020
GOKARNA
INDRAVATI(GR)
INDRAVATI(PG)
JITPL
KAHALGAON
KALABADIA
KEONJHOR
KHARAGPUR
KISHNGUNJ
KOLAGHAT
kV
420
415
410
405
400
395
390
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
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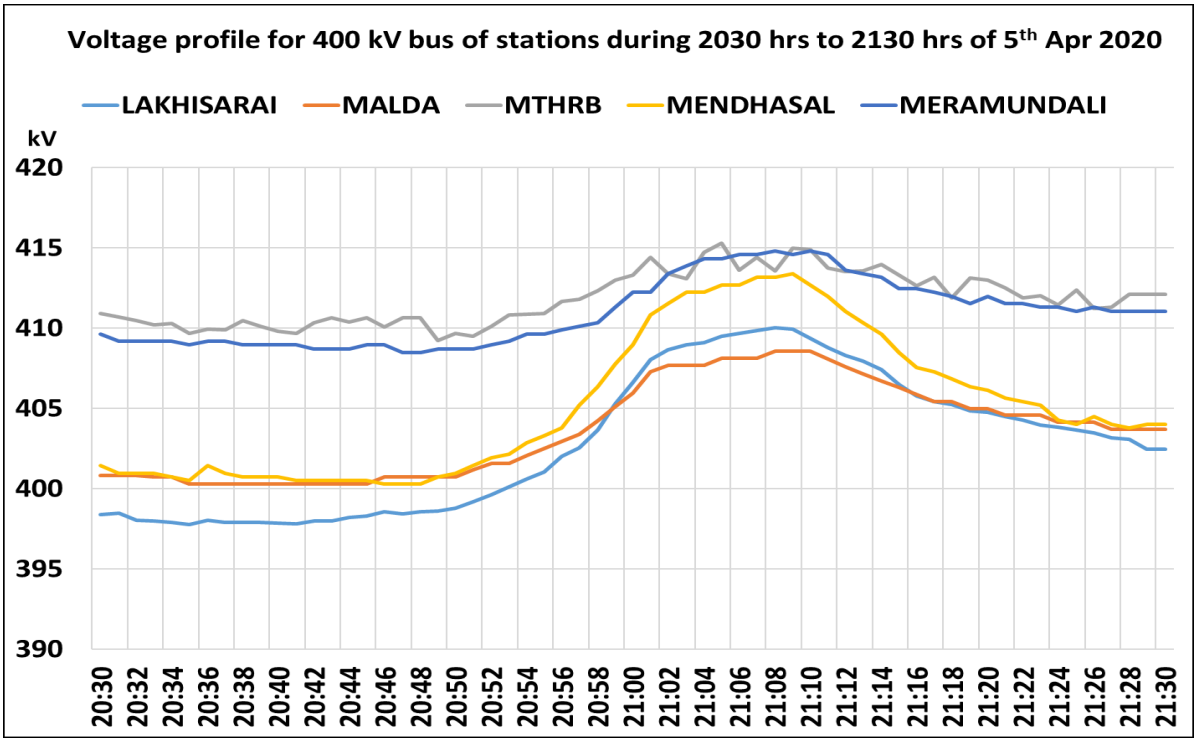
Voltage profile for 400 kV bus of stations during 2030 hrs to 2130 hrs of 5th Apr 2020
LAKHISARAI
MALDA
MTHRB
MENDHASAL
MERAMUNDALI
kV
420
415
410
405
400
395
390
20:30
20:32
20:34
20:36
20:38
20:40
20:42
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20:46
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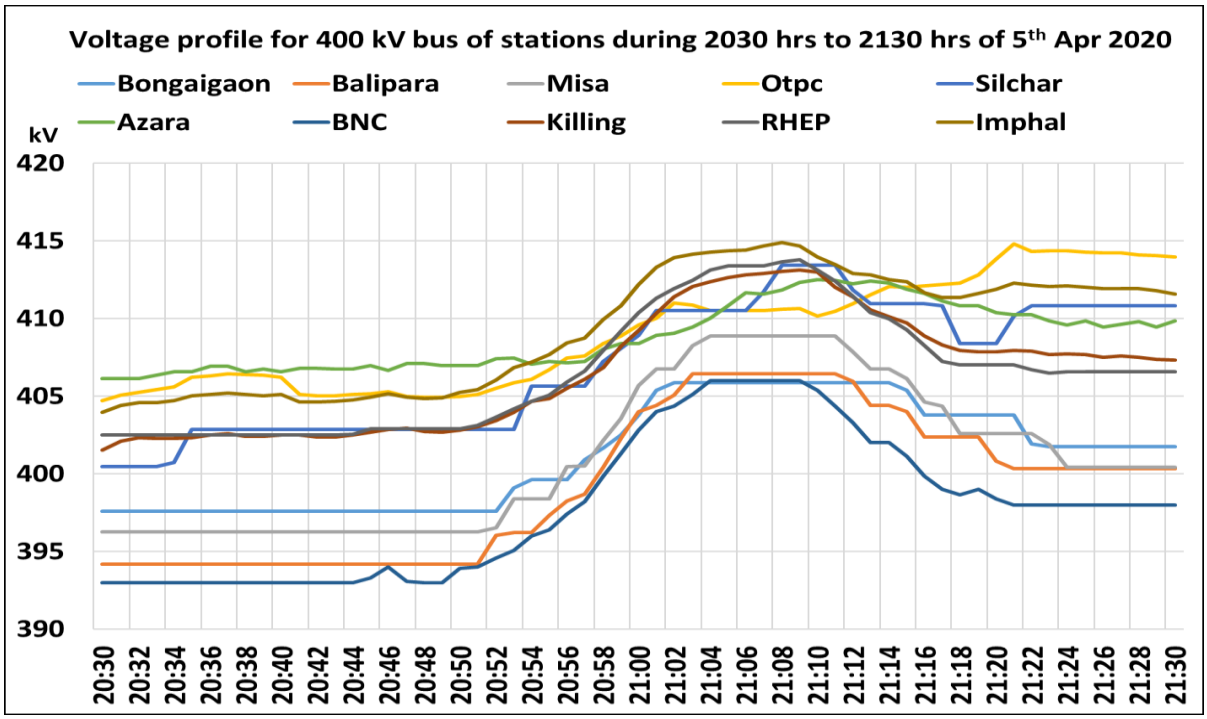
Voltage profile for 400 kV bus of stations during 2030 hrs to 2130 hrs of 5th Apr 2020
Bongaigaon
Balipara
Misa
Otpc
Silchar
Azara
BNC
Killing
RHEP
Imphal
kV
420
415
410
405
400
395
390
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
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21:28
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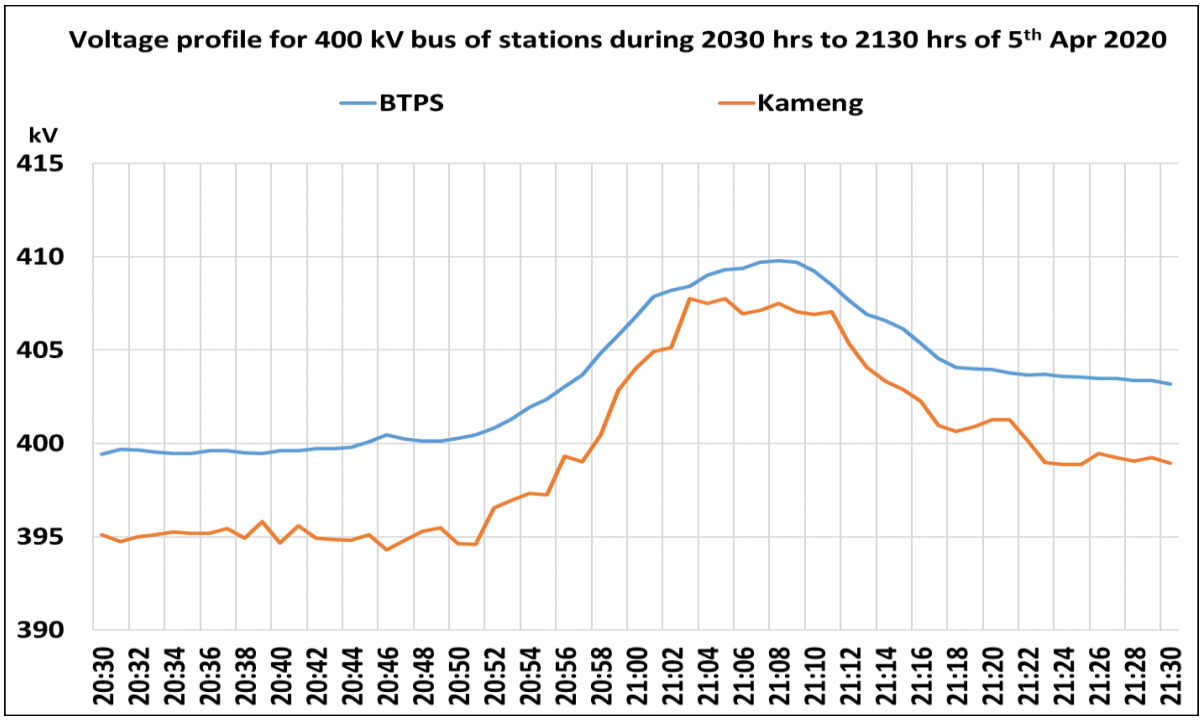
Voltage profile for 400 kV bus of stations during 2030 hrs to 2130 hrs of 5th Apr 2020
BTPS
Kameng
kV
415
410
405
400
395
390
20:30
20:32
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20:36
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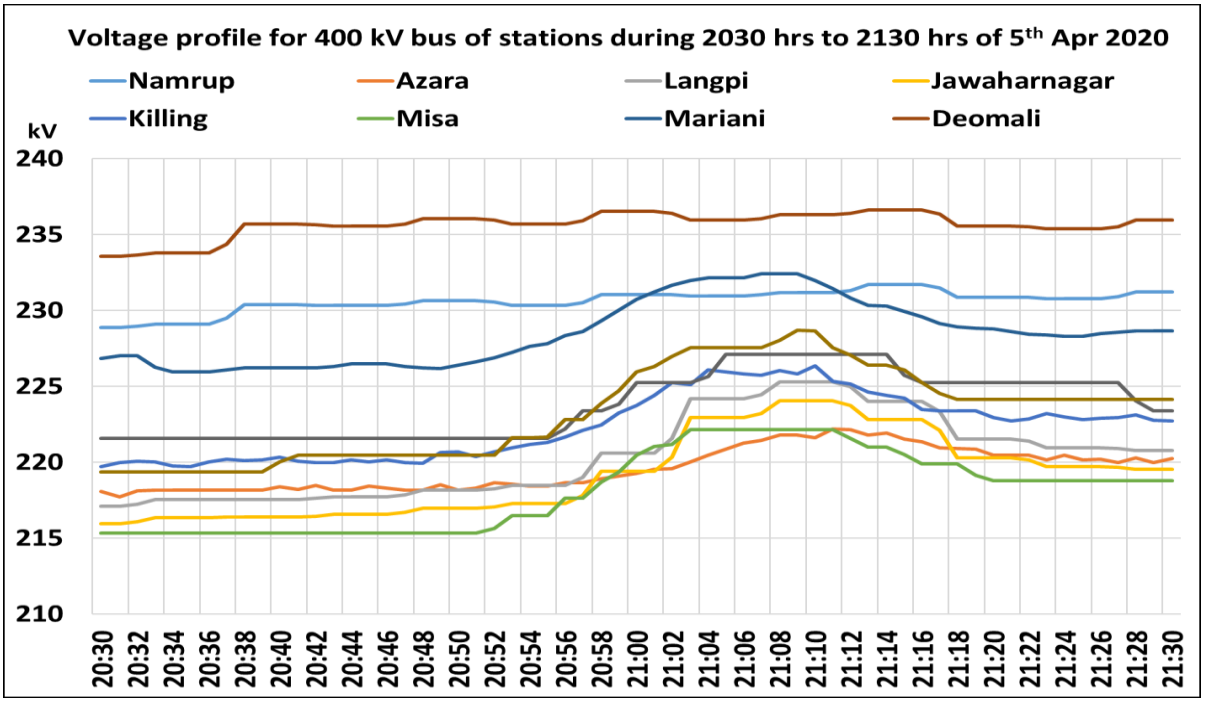
Voltage profile for 400 kV bus of stations during 2030 hrs to 2130 hrs of 5th Apr 2020
Namrup
Azara
Langpi
Jawaharnagar
Killing
Misa
Mariani
Deomali
kV
240
235
230
225
220
215
210
20:30
20:32
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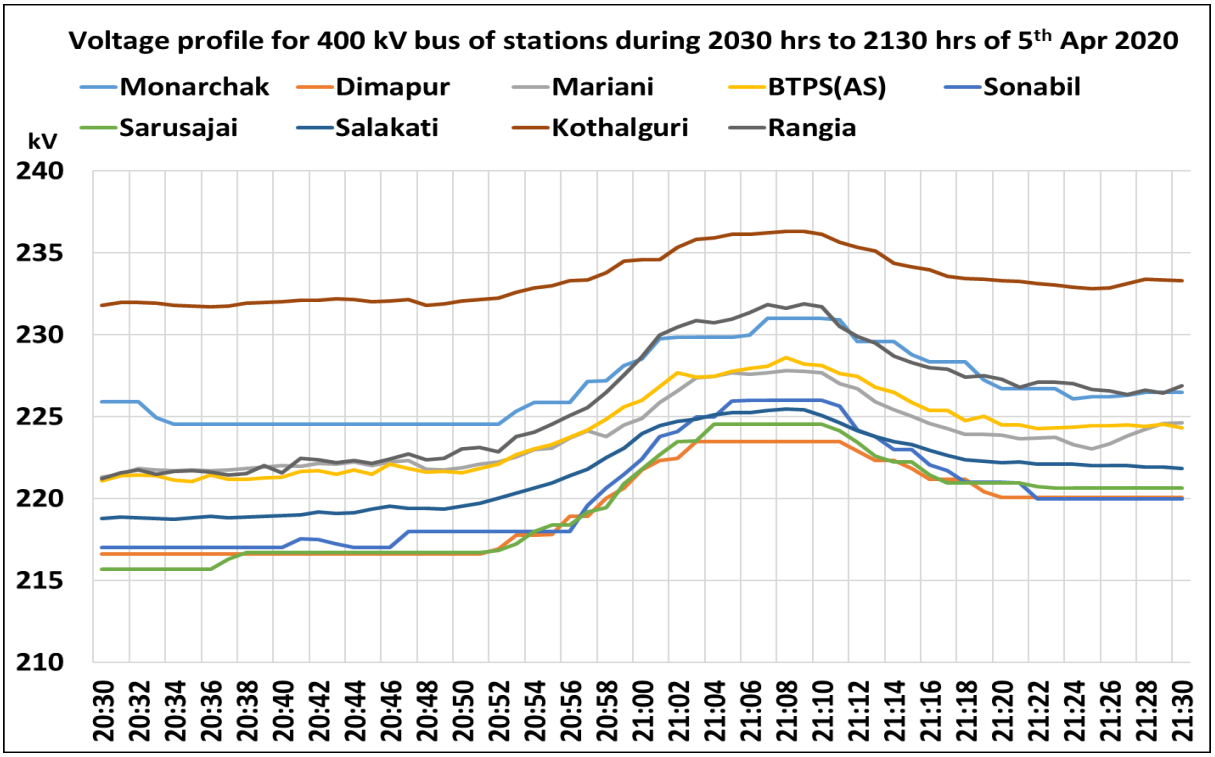
Voltage profile for 400 kV bus of stations during 2030 hrs to 2130 hrs of 5th Apr 2020
Monarchak
Dimapur
Mariani
BTPS(AS)
Sonabil
Sarusajai
Salakati
Kothalguri
Rangia
kV
240
235
230
225
220
215
210
20:30
20:32
20:34
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Annexure 11.4 Details of Voltage Unbalance at 765 kV and 400 kV Stations

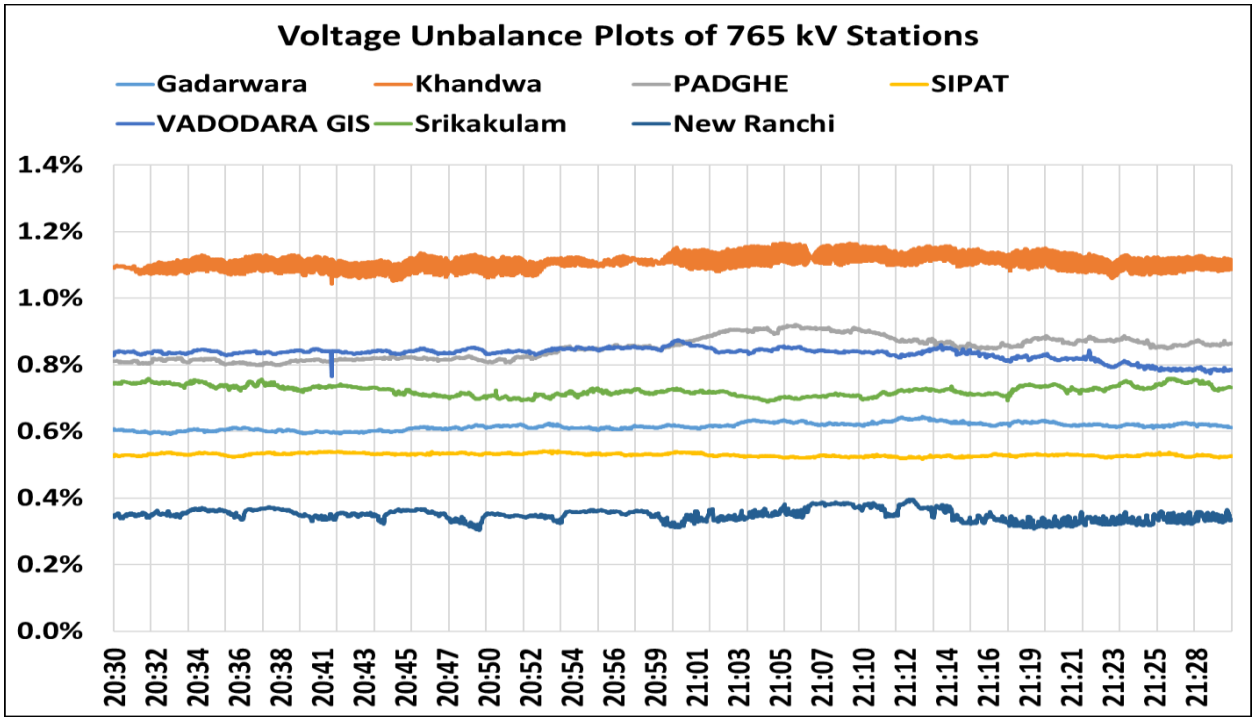
S.No.	Station Name	State	Region	Voltage Unbalance (%)		
				Average	Maximum	Minimum
1	ABDULLAPUR	Haryana	NR	0.89	1.15	0.65
2	AGRA PG	Uttar Pradesh	NR	0.62	0.72	0.52
3	AMRITSAR	Punjab	NR	1.11	1.21	1.07
4	AZAMGARH	Uttar Pradesh	NR	0.95	0.98	0.92
5	BALLABGARH	Haryana	NR	0.50	0.55	0.44
6	BAHADURGARH	Haryana	NR	0.97	1.00	0.93
7	BHIWADI	Rajasthan	NR	0.24	0.51	0.07
8	BHIWANI BBMB	Haryana	NR	0.89	0.96	0.81
9	PARBATI 1	Himachal Pradesh	NR	0.50	0.57	0.44
10	CHAMBA GIS	Himachal Pradesh	NR	0.58	0.67	0.48
11	Dadri PG	Uttar Pradesh	NR	0.66	0.71	0.60
12	GURGAON	Haryana	NR	0.63	0.74	0.58
13	HEERAPURA	Rajasthan	NR	1.35	1.43	1.24
14	HAMIRPUR	Himachal Pradesh	NR	0.34	0.45	0.28
15	JALANDHAR	Punjab	NR	1.25	1.33	1.22
16	JODHPUR	Rajasthan	NR	0.70	0.82	0.61
17	KAITHAL	Himachal Pradesh	NR	0.48	0.67	0.31
18	KANPUR 400	Uttar Pradesh	NR	0.75	0.86	0.66
19	KOLDAM	Himachal Pradesh	NR	0.79	0.94	0.70
20	KOTESHWAR	Uttarakhand	NR	0.42	0.50	0.34
21	LUCKNOW PG	Uttar Pradesh	NR	0.44	0.49	0.37
22	MANDOLA	Uttar Pradesh	NR	0.38	0.46	0.30
23	MANESAR	Haryana	NR	0.60	0.68	0.55
24	MAHARANI BAGH	Delhi	NR	0.56	0.62	0.49
25	MALERKOTLA	Punjab	NR	1.19	1.27	1.12
26	MORADABAD	Uttar Pradesh	NR	0.54	0.57	0.50
27	MUZAFFARNAGAR	Uttar Pradesh	NR	0.62	0.73	0.51
28	NALLAGARH	Himachal Pradesh	NR	0.23	0.32	0.17
29	NAPTA JAKHRI	Himachal Pradesh	NR	0.84	0.90	0.77
30	PANKI	Uttar Pradesh	NR	0.53	0.65	0.42
31	PARBATI	Himachal Pradesh	NR	0.50	0.57	0.44
32	PATIALA	Punjab	NR	0.56	0.63	0.51
33	RIHAND HVDC	Uttar Pradesh	NR	0.19	0.21	0.17

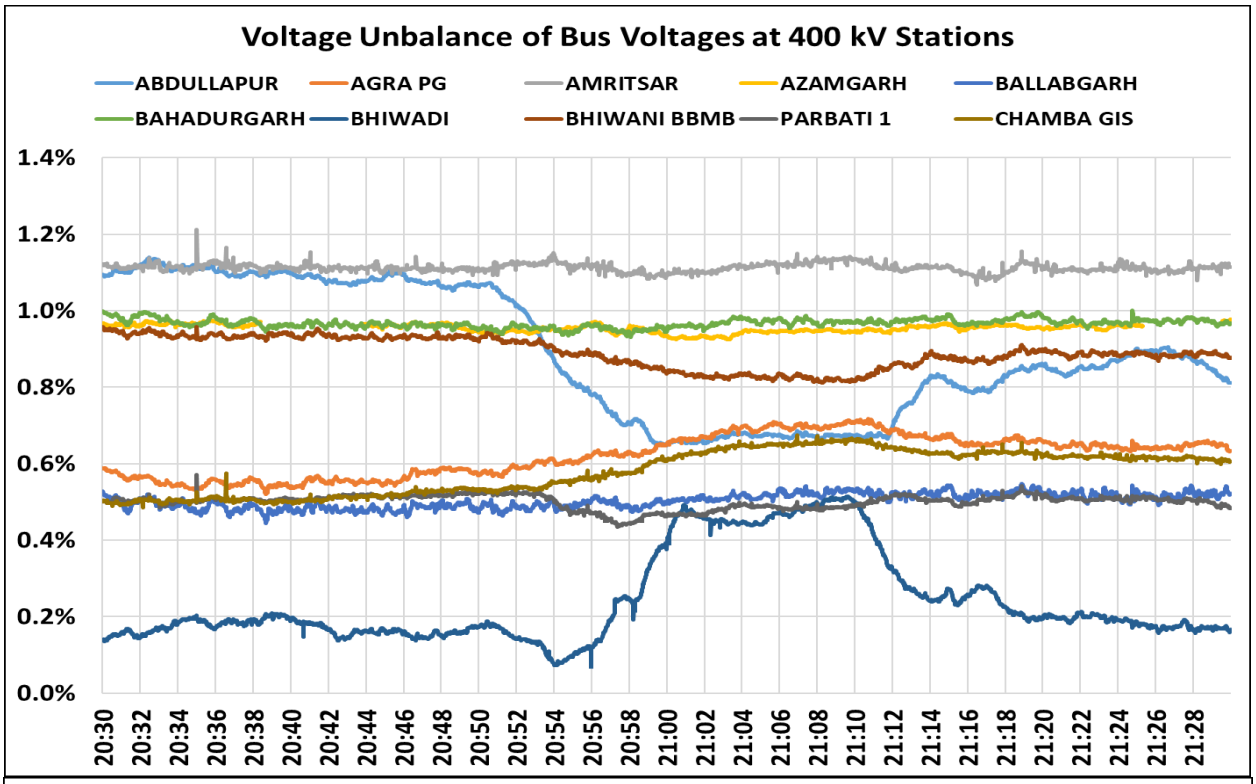
S.No.	Station Name	State	Region	Voltage Unbalance (%)		
				Average	Maximum	Minimum
34	RIHAND NT	Uttar Pradesh	NR	0.15	0.18	0.12
35	SINGRAULI	Uttar Pradesh	NR	0.33	0.36	0.31
36	TEHRI THDC	Uttarakhand	NR	0.69	0.77	0.61
37	VARANASI 765	Uttar Pradesh	NR	0.58	0.64	0.52
38	SARNATH	Uttar Pradesh	NR	0.53	0.62	0.44
39	ADANI	Gujarat	WR	0.40	0.43	0.37
40	AMRELI	Gujarat	WR	1.36	1.47	1.27
41	ASOJ	Gujarat	WR	0.59	0.68	0.46
42	BHADRAVATI	Maharashtra	WR	0.78	0.81	0.75
43	BHILAI	Chhattisgarh	WR	0.26	0.31	0.22
44	BHOPAL	MP	WR	0.89	1.08	0.77
45	BINA MP	MP	WR	0.71	0.75	0.66
46	BOISAR	Chhattisgarh	WR	0.92	0.97	0.88
47	CHANDRAPUR	Maharashtra	WR	0.72	0.81	0.65
48	RANCHODPURA	Gujarat	WR	1.40	1.48	1.21
49	MAGARWADA GIS	Gujarat	WR	0.75	0.78	0.73
50	INDORE MP 400	MP	WR	0.81	0.90	0.74
51	JABALPUR	MP	WR	0.11	0.14	0.08
52	Jetpur	Gujarat	WR	0.48	0.52	0.41
53	GANDHAR (JHANOR)	Gujarat	WR	0.53	0.57	0.50
54	KALA GIS	Maharashtra	WR	0.68	0.74	0.61
55	Kalwa CS	Maharashtra	WR	1.18	1.32	1.00
56	KALWA	Maharashtra	WR	1.20	1.45	1.00
57	KHANDWA	MP	WR	0.89	0.92	0.86
58	KOLHAPUR 200	Maharashtra	WR	0.72	0.90	0.59
59	KANSARI	Gujarat	WR	0.27	0.30	0.19
60	KORBA WEST	Chhattisgarh	WR	0.93	1.12	0.79
61	KOSAMBA	Gujarat	WR	0.68	0.73	0.60
62	KASOR	Gujarat	WR	0.70	0.74	0.67
63	KORBA STPS	Chhattisgarh	WR	0.42	0.46	0.39
64	KATNI	MP	WR	1.32	1.48	1.18
65	LONIKAND	Maharashtra	WR	0.94	0.98	0.92
66	NAGDA	MP	WR	0.65	0.72	0.59
67	NAVSARI	Gujarat	WR	0.61	0.67	0.55
68	RAIPUR 400	Chhattisgarh	WR	0.41	0.45	0.38

S.No.	Station Name	State	Region	Voltage Unbalance (%)		
				Average	Maximum	Minimum
69	SARDARSAROVAR	Gujarat	WR	0.71	0.76	0.64
70	RIHAND NT	Uttar Pradesh	WR	0.15	0.18	0.12
71	SIPAT	Chhattisgarh	WR	0.66	0.69	0.64
72	SATNA 400	MP	WR	0.63	0.65	0.60
73	VAPI	Gujarat	WR	0.90	1.18	0.26
74	VADODARA GIS	Gujarat	WR	0.71	0.75	0.62
75	VERSANA GE	Gujarat	WR	0.58	0.60	0.56
76	VINDHYACHAL	MP	WR	0.54	0.56	0.50
77	ALAMATHY	Tamil Nadu	SR	0.21	0.26	0.17
78	BIDADI	Karnataka	SR	0.53	0.60	0.48
79	GOOTY	Andhra Pradesh	SR	0.79	0.84	0.73
80	GUTTUR	Karnataka	SR	0.86	0.92	0.80
81	HIRIYUR	Karnataka	SR	1.20	1.31	1.09
82	HOSUR	Tamil Nadu	SR	0.60	0.69	0.45
83	JEYPORE	Orissa	SR	1.01	1.20	0.87
84	KAIGA	Tamil Nadu	SR	0.26	1.21	0.18
85	KUDGI / NARENDRA	Karnataka	SR	0.39	0.42	0.35
86	KUDANKULAM	Tamil Nadu	SR	0.49	0.63	0.40
87	KHAMMAM 400	Andhra Pradesh	SR	0.64	0.71	0.59
88	KOLAR	Karnataka	SR	0.35	0.41	0.30
89	MAHBUBNAGAR	Telangana	SR	0.76	0.90	0.69
90	MADURAI	Tamil Nadu	SR	0.74	0.87	0.60
91	MUNIRABAD	Karnataka	SR	0.48	0.56	0.42
92	MYSORE	Karnataka	SR	0.49	0.75	0.25
93	NELLORE 400	Andhra Pradesh	SR	1.07	1.17	1.00
94	NAGAPATTINAM	Tamil Nadu	SR	0.41	0.47	0.36
95	NEELAMANGALA	Karnataka	SR	0.53	0.59	0.49
96	NEYVELI TS 2	Tamil Nadu	SR	0.31	0.34	0.25
97	NEYVELLI TS-1 EXT	Tamil Nadu	SR	1.24	1.29	1.20
98	NEYVELI TS-2 EXP	Tamil Nadu	SR	0.47	0.53	0.42
99	NARENDRA	Karnataka	SR	0.06	0.11	0.03
100	KURNOOL AP	Andhra Pradesh	SR	0.62	0.66	0.59
101	NAGARJUNA SAGAR	Andhra Pradesh	SR	0.39	0.46	0.33
102	NUNNA / VIJAYAWADA	Andhra Pradesh	SR	0.62	0.68	0.58
103	RAMAGUNDAM STPS	Andhra Pradesh	SR	0.77	0.81	0.73

S.No.	Station Name	State	Region	Voltage Unbalance (%)		
				Average	Maximum	Minimum
104	RAICHUR TPS 400	Karnataka	SR	0.99	1.02	0.95
105	SALEM	Tamil Nadu	SR	0.73	0.82	0.66
106	SRISAILEM	Andhra Pradesh	SR	0.61	0.69	0.53
107	SIMHADRI	Andhra Pradesh	SR	0.28	0.36	0.15
108	SOMANAHALLI	Karnataka	SR	0.24	0.32	0.18
109	SRIPERUMBUDUR	Tamil Nadu	SR	0.68	0.73	0.63
110	TRIVENDRUM	Kerala	SR	1.00	1.12	0.63
111	VTS STAGE IV	Andhra Pradesh	SR	0.37	0.43	0.32
112	YELAHANKA	Karnataka	SR	0.49	0.56	0.43
113	ARAMBAGH	West Bengal	ER	0.49	0.57	0.41
114	BAKRESHWAR	West Bengal	ER	1.35	1.44	1.25
115	BARH	BIHAR	ER	0.55	0.58	0.52
116	BIHAR SHARIF 400	Bihar	ER	0.94	0.98	0.90
117	BOKARO TPS	Jharkhand	ER	0.50	0.56	0.44
118	400 kV Jharkhand Pooling (Chandwa)	Jharkhand	ER	0.50	0.58	0.40
119	DSTPS	West Bengal	ER	0.42	0.47	0.40
120	DURGAPUR	West Bengal	ER	0.31	0.34	0.27
121	FARAKKA	West Bengal	ER	0.84	0.90	0.79
122	JAMSHEDPUR	Jharkhand	ER	0.62	0.66	0.58
123	JEERAT	West Bengal	ER	0.85	0.91	0.74
124	JEYPORE	Orissa	ER	1.01	1.20	0.87
125	KALABADIA	Orissa	ER	0.48	0.60	0.41
126	KISHANGANJ (KARANDIGHI)	Bihar	ER	0.58	0.62	0.54
127	KODERMA TPS	West Bengal	ER	0.72	0.80	0.66
128	KOLAGHAT	West Bengal	ER	1.12	1.18	1.06
129	MAITHON	Jharkhand	ER	0.77	0.83	0.72
130	MALDA	West Bengal	ER	0.25	0.32	0.19
131	MENDHASAL	Orissa	ER	0.55	0.79	0.28
132	MERAMANDALI	Orissa	ER	1.01	1.11	0.85
133	MAITHON RB TPS	West Bengal	ER	0.62	0.67	0.54
134	MUZAFFARPUR	Bihar	ER	0.87	0.92	0.80
135	UTTARA	Orissa	ER	0.49	0.69	0.25
136	RAGHUNATHPUR TPS	West Bengal	ER	0.76	0.81	0.71
137	RAJARHAT	West Bengal	ER	0.85	0.93	0.71

S.No.	Station Name	State	Region	Voltage Unbalance (%)		
				Average	Maximum	Minimum
138	RANGPO	Sikkim	ER	0.37	0.47	0.29
139	ROURKELA	Orissa	ER	0.16	0.23	0.08
140	BINNAGURI	West Bengal	ER	0.79	0.86	0.74
141	SHUBHASHGRAM	West Bengal	ER	1.14	1.33	0.76
142	TALCHER	Orissa	ER	0.27	0.34	0.19
143	BONGAIGAON 400	Assam	ER	0.40	0.44	0.30
144	FARAKKA	West Bengal	ER	0.84	0.90	0.79
145	KISHANGANJ (KARANDIGHI)	Bihar	ER	0.58	0.62	0.54
146	KASBA	West Bengal	ER	0.45	0.53	0.37
147	BINNAGURI	West Bengal	ER	0.79	0.86	0.74




Voltage Unbalance of Bus Voltages at 400 kV Stations
ABDULLAPUR
AGRA PG
AMRITSAR
AZAMGARH
BALLABGARH
BAHADURGARH
BHIWADI
BHIWANI BBMB
PARBATI 1
CHAMBA GIS
1.4%
1.2%
1.0%
0.8%
0.6%
0.4%
0.2%
0.0%
20:30
20:32
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20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
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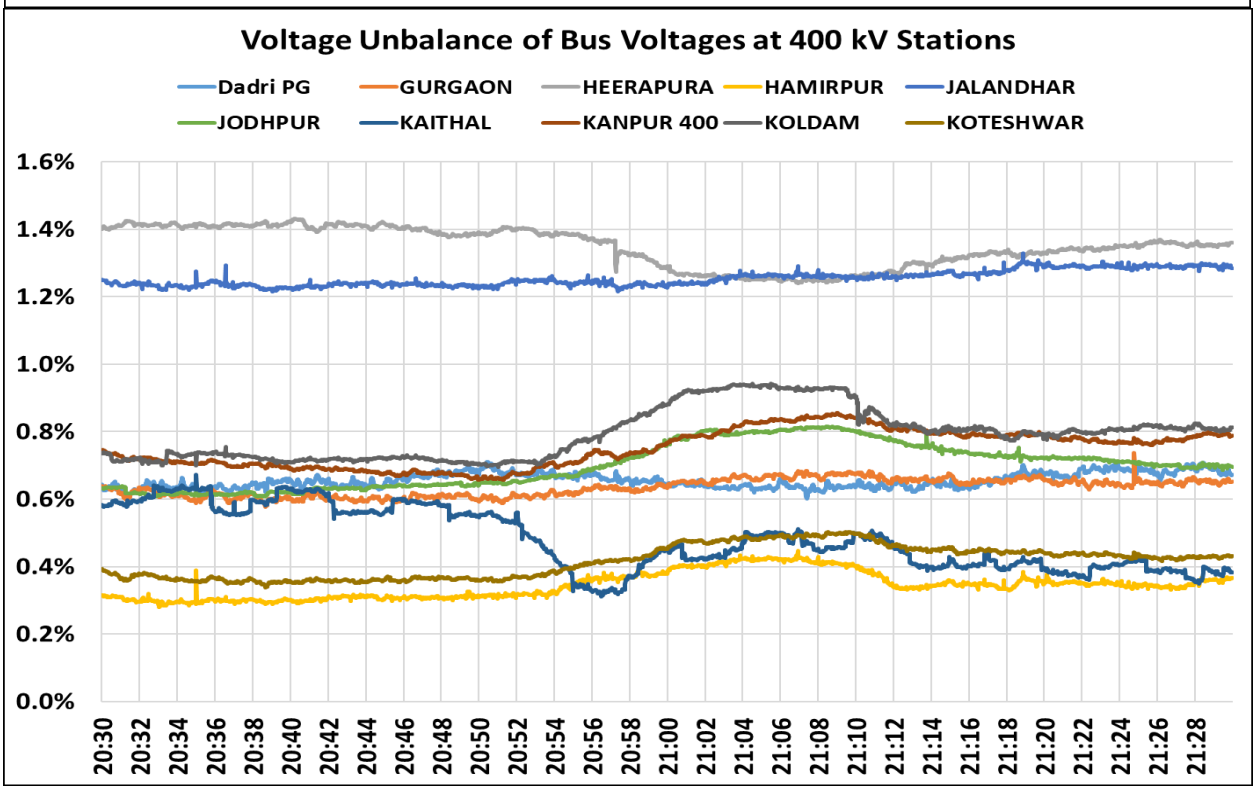
Voltage Unbalance of Bus Voltages at 400 kV Stations
Dadri PG
GURGAON
HEERAPURA
HAMIRPUR
JALANDHAR
JODHPUR
KAITHAL
KANPUR 400
KOLDAM
KOTESHWAR
1.6%
1.4%
1.2%
1.0%
0.8%
0.6%
0.4%
0.2%
0.0%
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20:32
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20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
21:04
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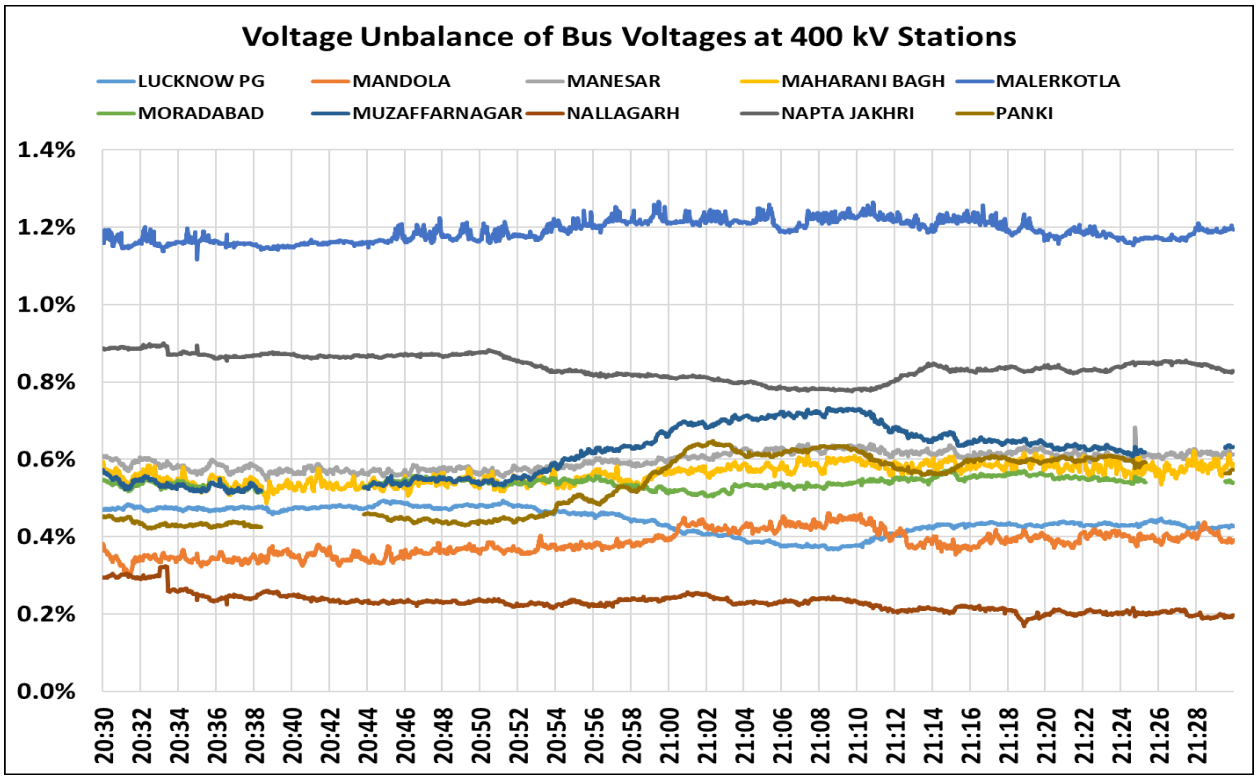
Voltage Unbalance of Bus Voltages at 400 kV Stations
LUCKNOW PG
MANDOLA
MANESAR
MAHARANI BAGH
MALERKOTLA
MORADABAD
MUZAFFARNAGAR
NALLAGARH
NAPTA JAKHRI
PANKI
1.4%
1.2%
1.0%
0.8%
0.6%
0.4%
0.2%
0.0%
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:44
20:46
20:48
20:50
20:52
20:54
20:56
20:58
21:00
21:02
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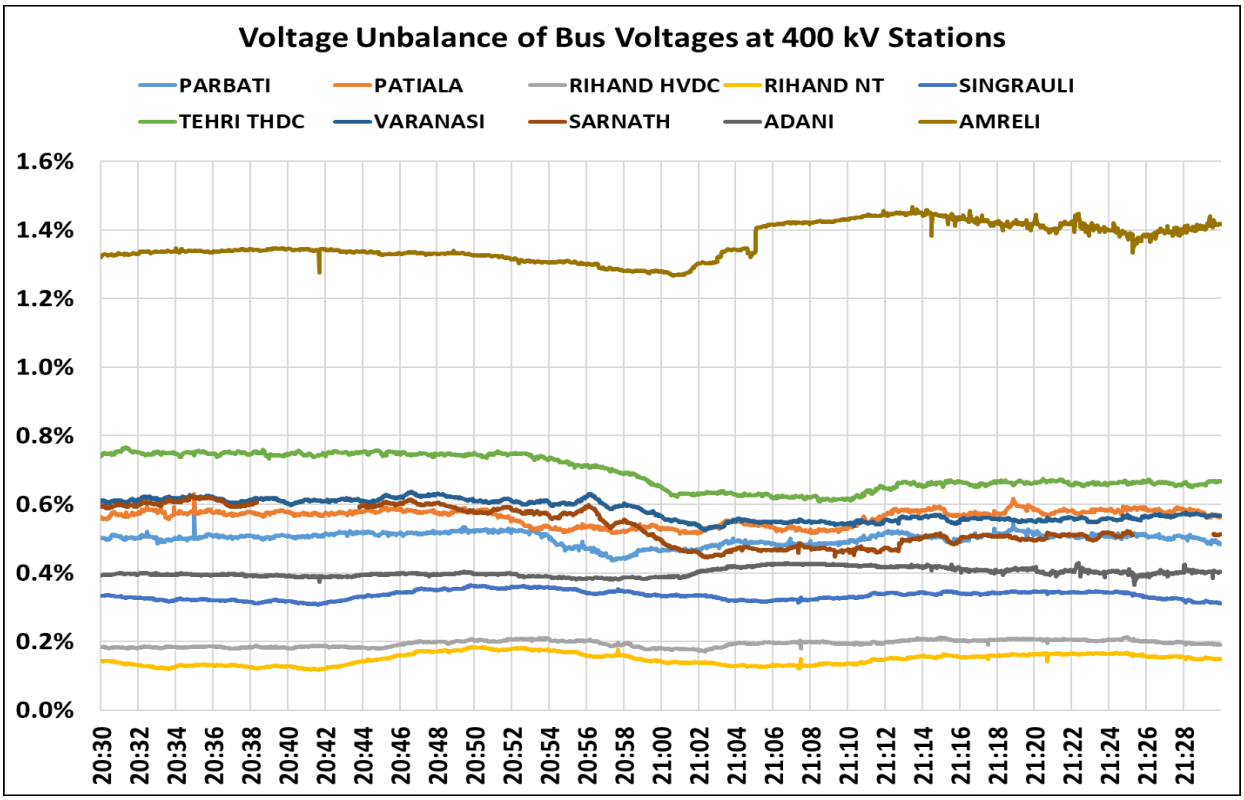
21:28


Voltage Unbalance of Bus Voltages at 400 kV Stations
PARBATI
PATIALA
RIHAND HVDC
RIHAND NT
SINGRAULI
TEHRI THDC
VARANASI
SARNATH
ADANI
AMRELI
1.6%
1.4%
1.2%
1.0%
0.8%
0.6%
0.4%
0.2%
0.0%
20:30
20:32
20:34
20:36
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20:54
20:56
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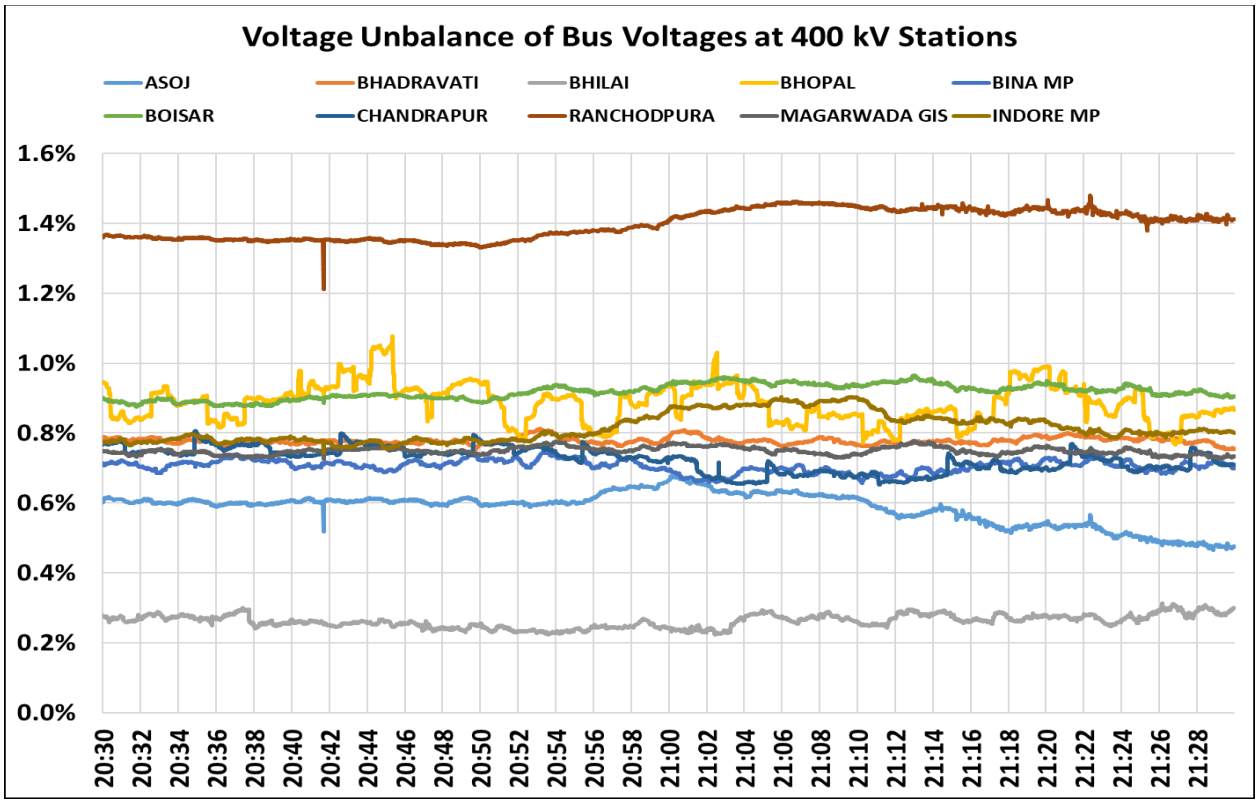
21:28


Voltage Unbalance of Bus Voltages at 400 kV Stations
ASOJ
BHADRAVATI
BHILAI
BHOPAL
BINA MP
BOISAR
CHANDRAPUR
RANCHODPURA
MAGARWADA GIS
INDORE MP
1.6%
1.4%
1.2%
1.0%
0.8%
0.6%
0.4%
0.2%
0.0%
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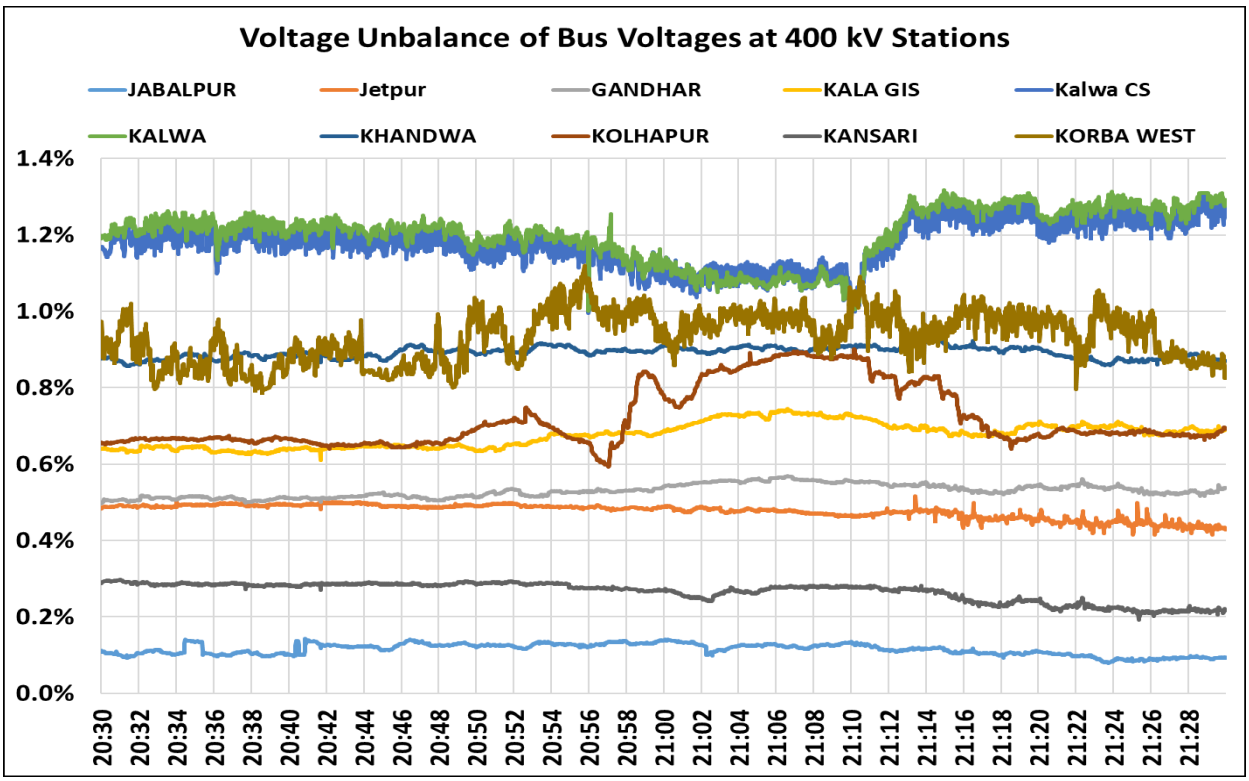
Voltage Unbalance of Bus Voltages at 400 kV Stations
JABALPUR
Jetpur
GANDHAR
KALA GIS
Kalwa CS
KALWA
KHANDWA
KOLHAPUR
KANSARI
KORBA WEST
1.4%
1.2%
1.0%
0.8%
0.6%
0.4%
0.2%
0.0%
20:30
20:32
20:34
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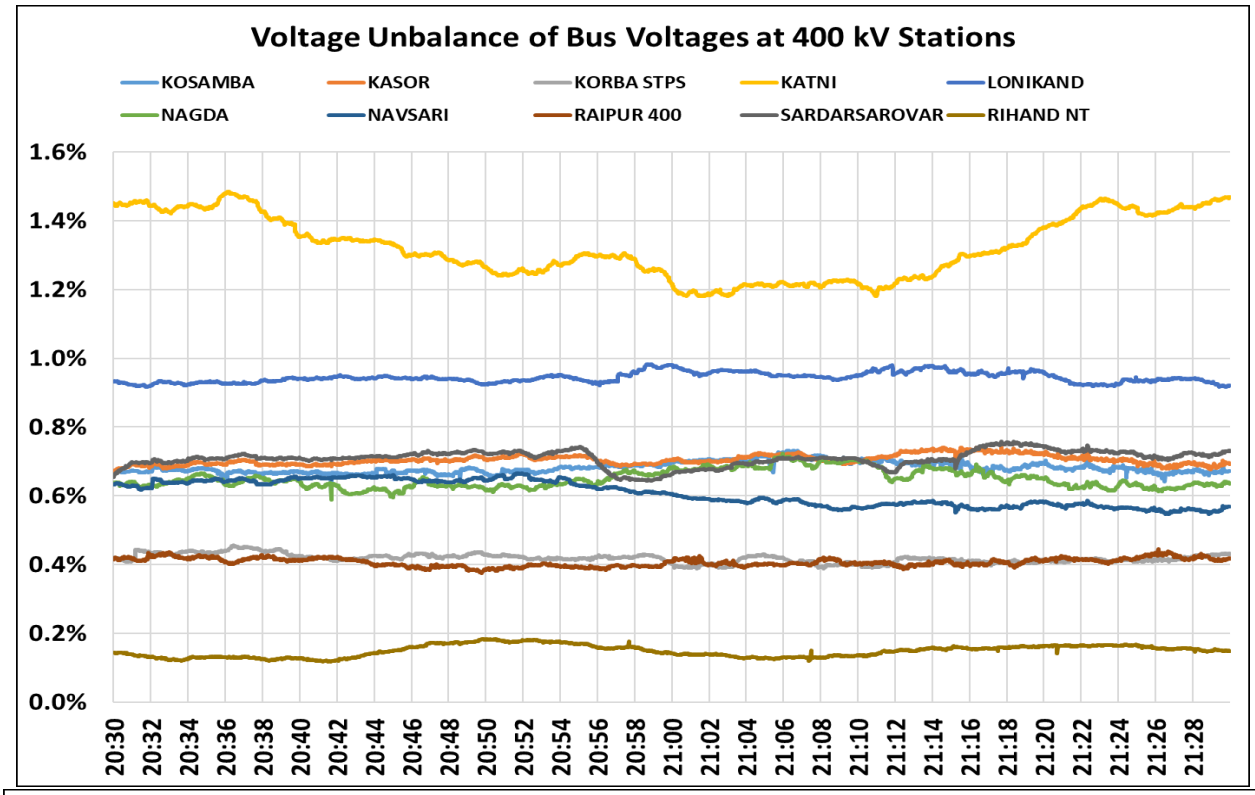
Voltage Unbalance of Bus Voltages at 400 kV Stations
KOSAMBA
KASOR
KORBA STPS
KATNI
LONIKAND
NAGDA
NAVSARI
RAIPUR 400
SARDARSAROVAR
RIHAND NT
1.6%
1.4%
1.2%
1.0%
0.8%
0.6%
0.4%
0.2%
0.0%
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20:56
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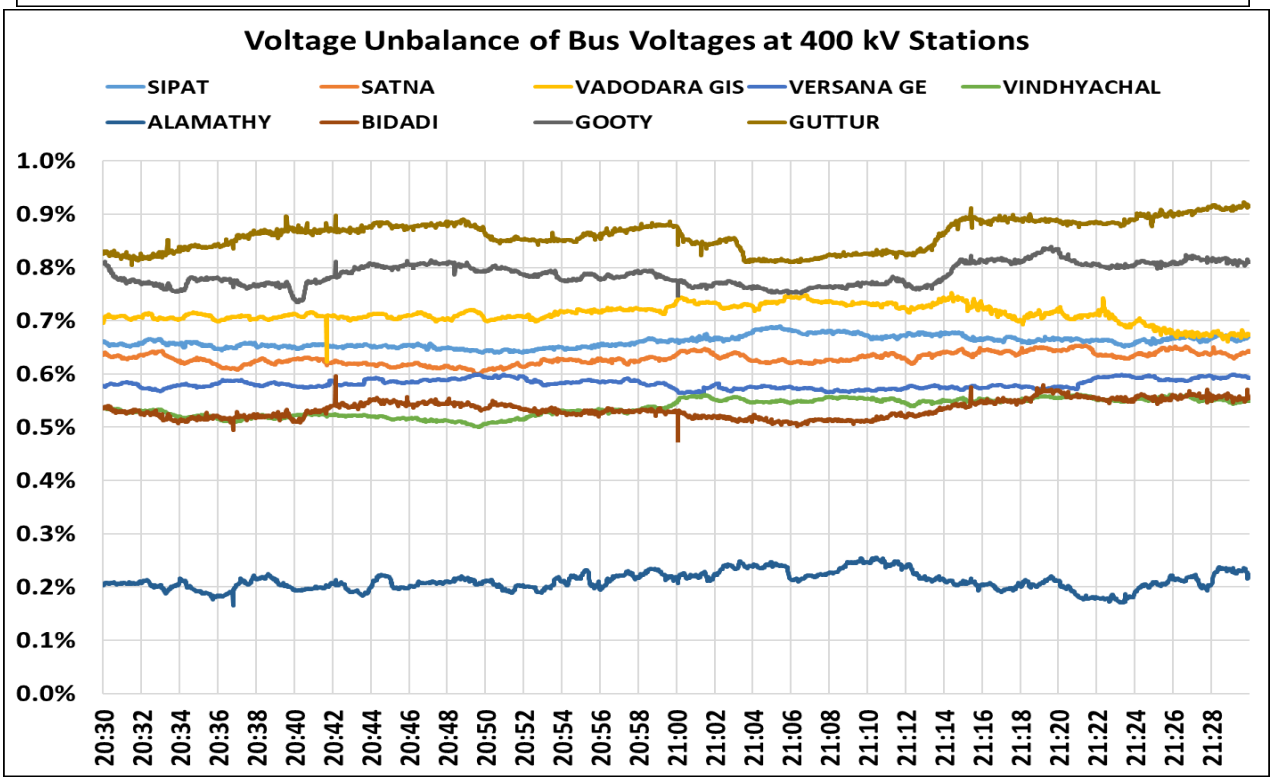
Voltage Unbalance of Bus Voltages at 400 kV Stations
SIPAT
SATNA
VADODARA GIS
VERSANA GE
VINDHYACHAL
ALAMATHY
BIDADI
GOOTY
GUTTUR
1.0%
0.9%
0.8%
0.7%
0.6%
0.5%
0.4%
0.3%
0.2%
0.1%
0.0%
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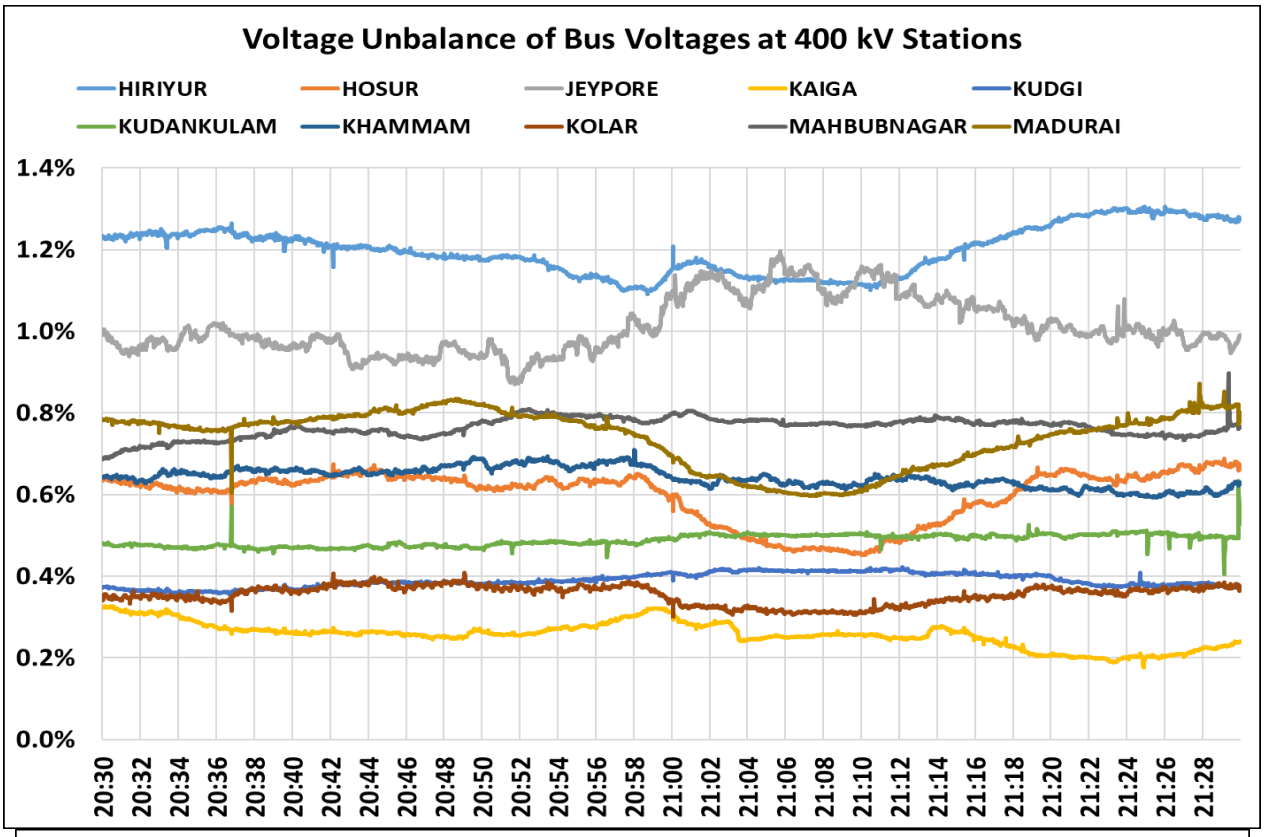
Voltage Unbalance of Bus Voltages at 400 kV Stations
HIRIYUR
HOSUR
JEYPORE
KAIGA
KUDGI
KUDANKULAM
KHAMMAM
KOLAR
MAHBUBNAGAR
MADURAI
1.4%
1.2%
1.0%
0.8%
0.6%
0.4%
0.2%
0.0%
20:30
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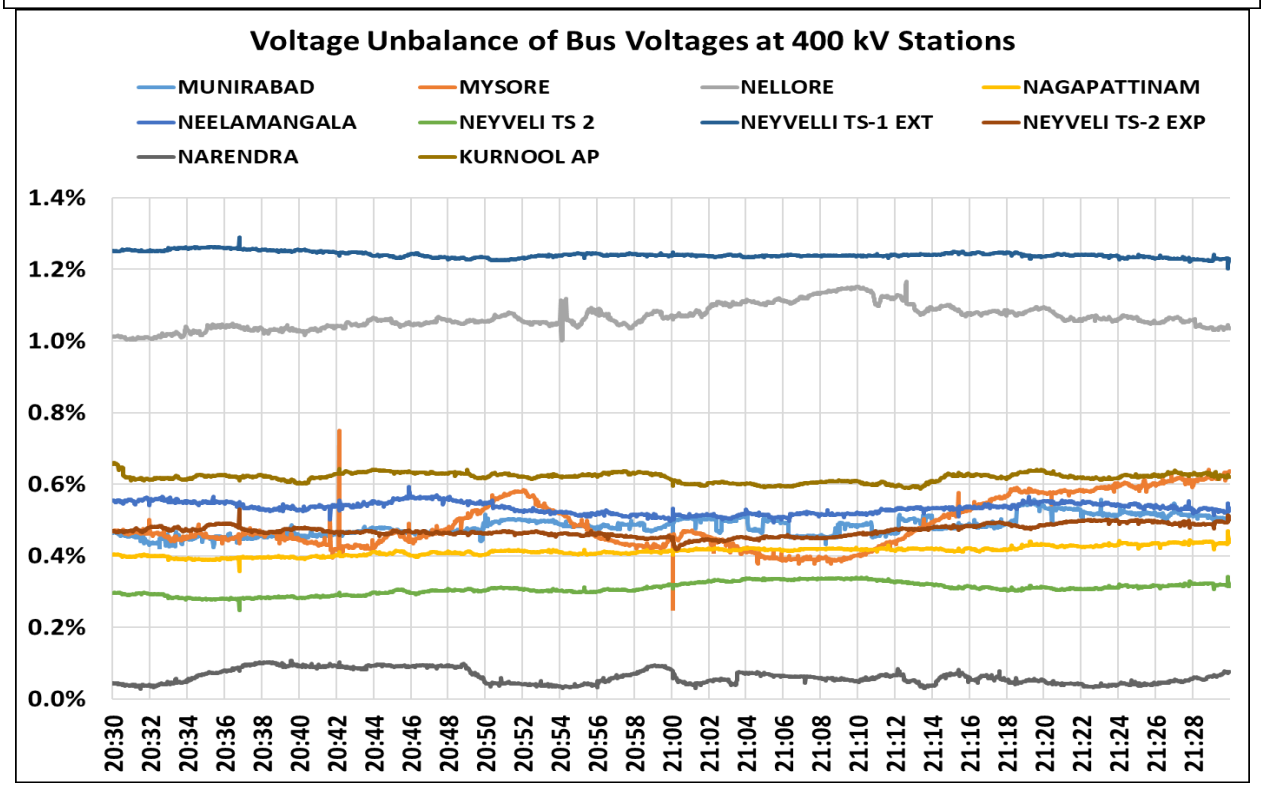
Voltage Unbalance of Bus Voltages at 400 kV Stations
MUNIRABAD
MYSORE
NELLORE
NAGAPATTINAM
NEELAMANGALA
NEYVELI TS 2
NEYVELLI TS-1 EXT
NEYVELI TS-2 EXP
NARENDRA
KURNOOL AP
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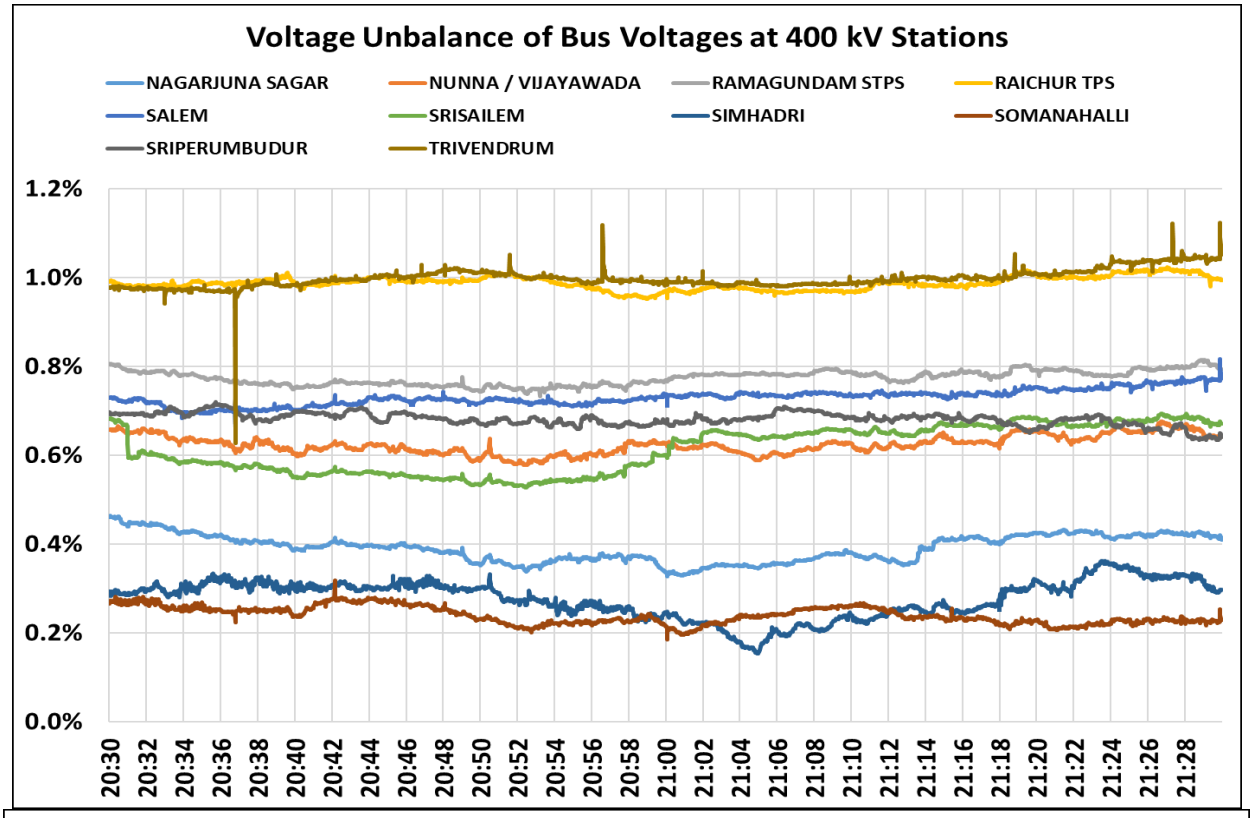
Voltage Unbalance of Bus Voltages at 400 kV Stations
NAGARJUNA SAGAR
NUNNA / VIJAYAWADA
RAMAGUNDAM STPS
RAICHUR TPS
SALEM
SRISAILEM
SIMHADRI
SOMANAHALLI
SRIPERUMBUDUR
TRIVENDRUM
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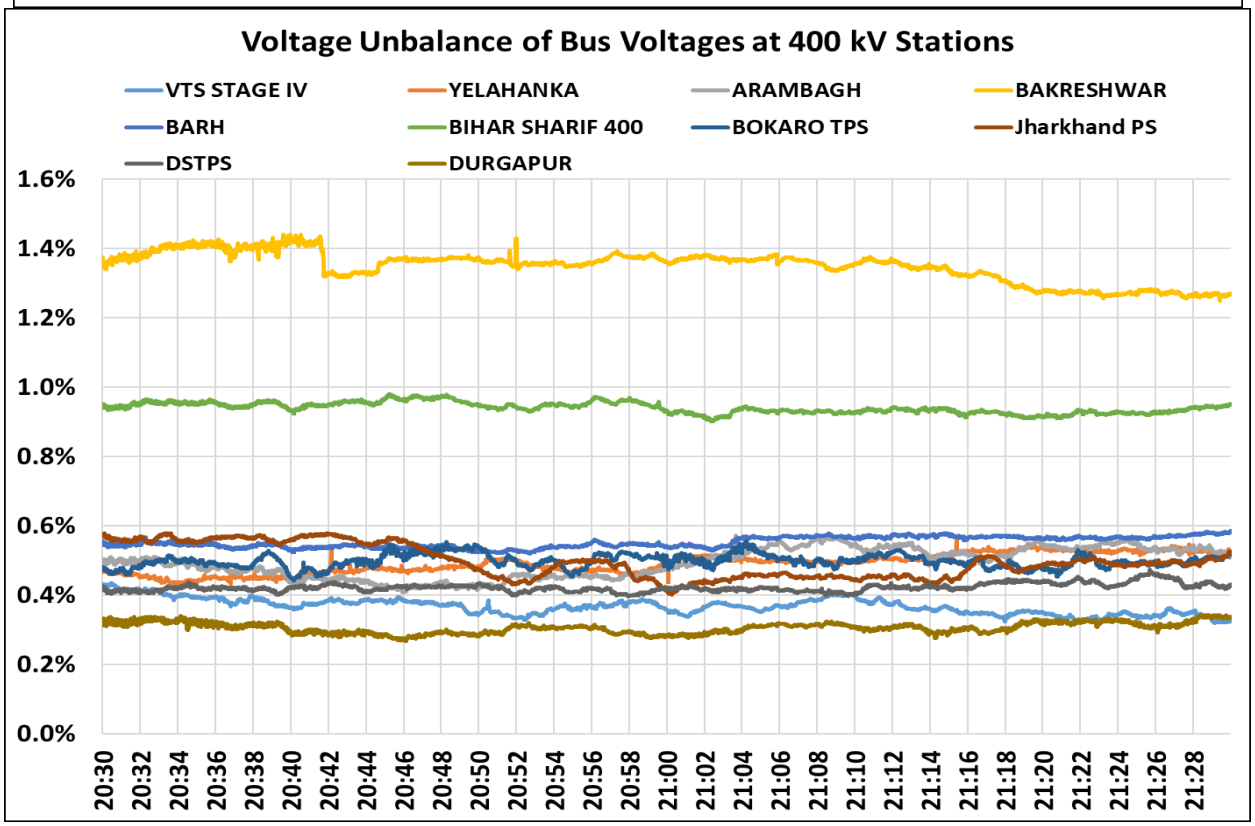
Voltage Unbalance of Bus Voltages at 400 kV Stations
VTS STAGE IV
YELAHANKA
ARAMBAGH
BAKRESHWAR
BARH
BIHAR SHARIF 400
BOKARO TPS
Jharkhand PS
DSTPS
DURGAPUR
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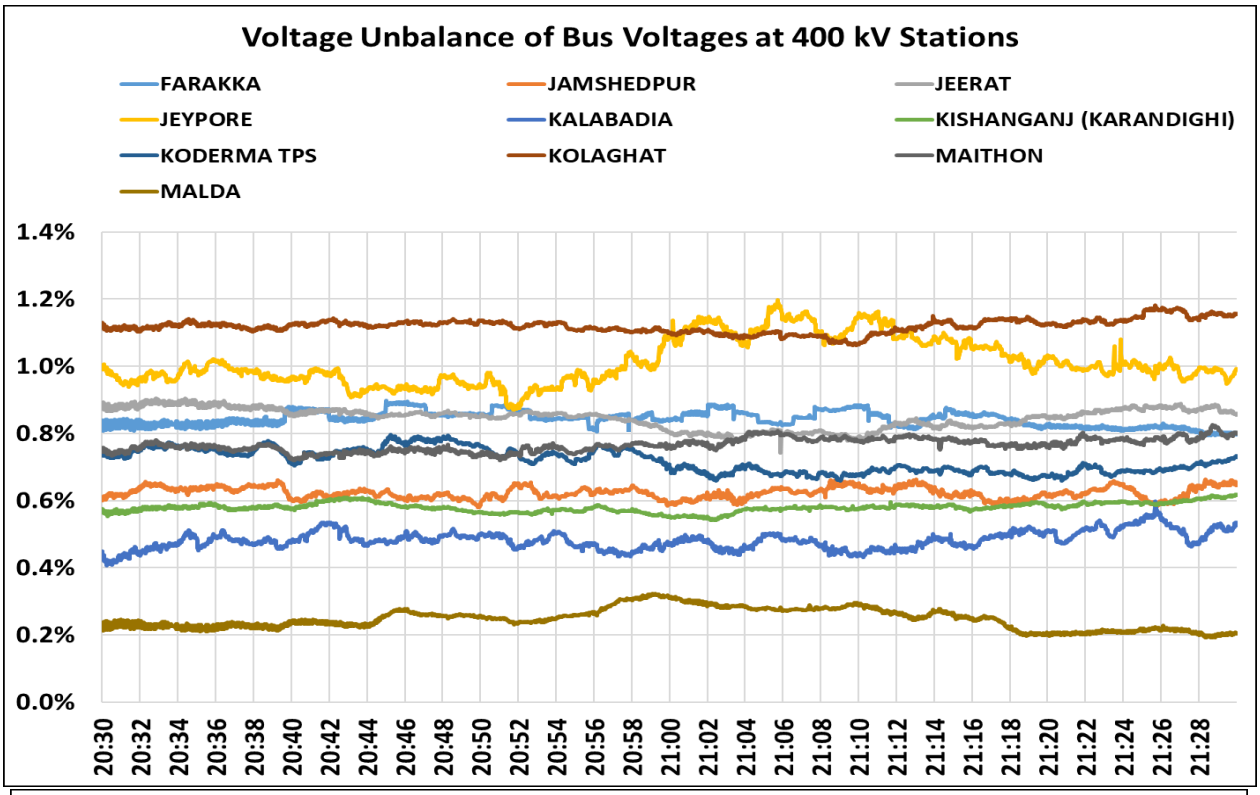
Voltage Unbalance of Bus Voltages at 400 kV Stations
FARAKKA
JAMSHEDPUR
JEERAT
JEYPORE
KALABADIA
KISHANGANJ (KARANDIGHI)
KODERMA TPS
KOLAGHAT
MAITHON
MALDA
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0.8%
0.6%
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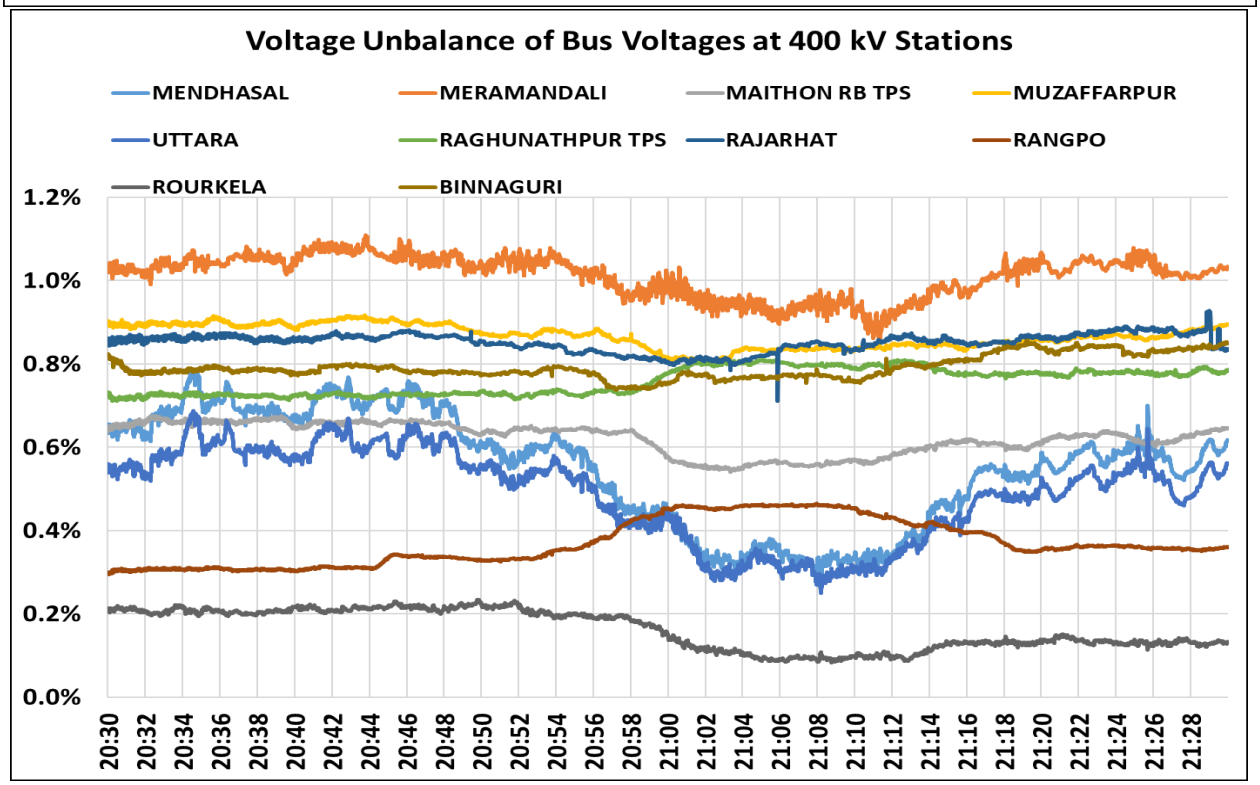
Voltage Unbalance of Bus Voltages at 400 kV Stations
MENDHASAL
MERAMANDALI
MAITHON RB TPS
MUZAFFARPUR
UTTARA
RAGHUNATHPUR TPS
RAJARHAT
RANGPO
ROURKELA
BINNAGURI
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0.8%
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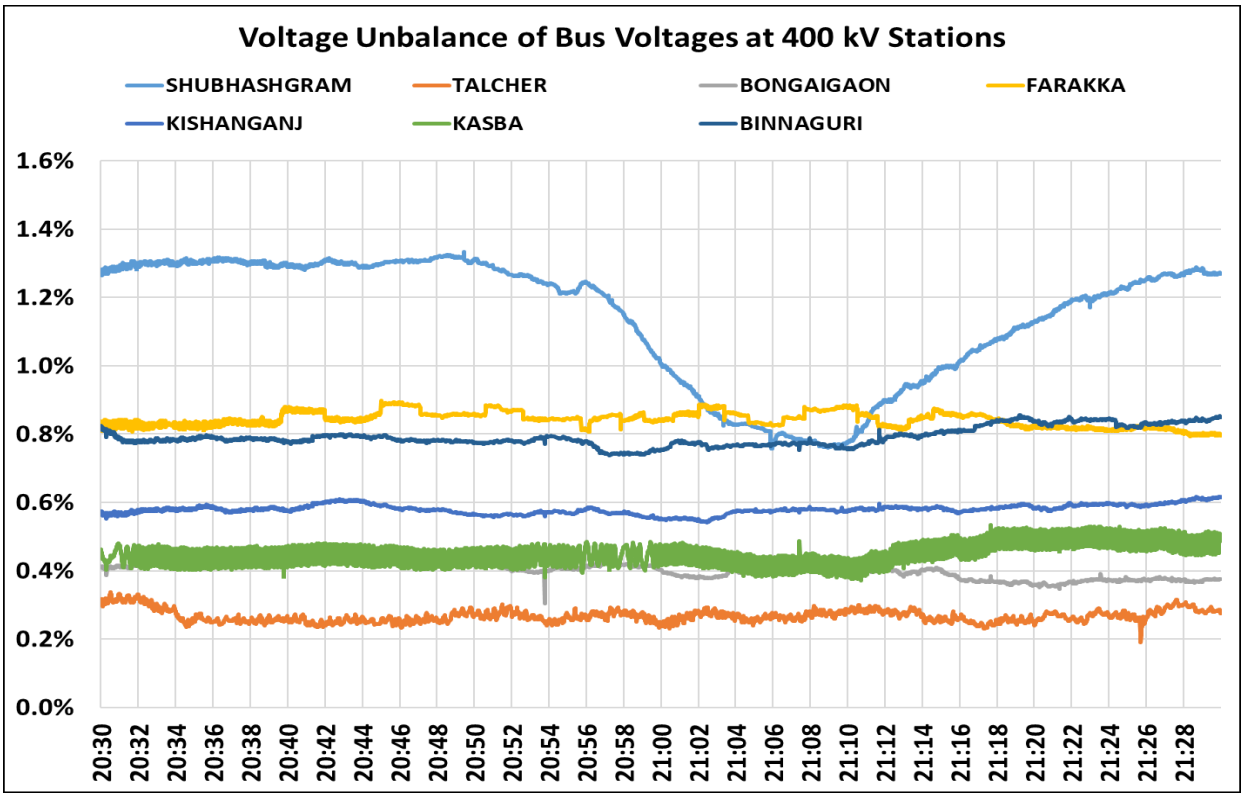
Voltage Unbalance of Bus Voltages at 400 kV Stations
SHUBHASHGRAM
TALCHER
BONGAIGAON
FARAKKA
KISHANGANJ
KASBA
BINNAGURI
1.6%
1.4%
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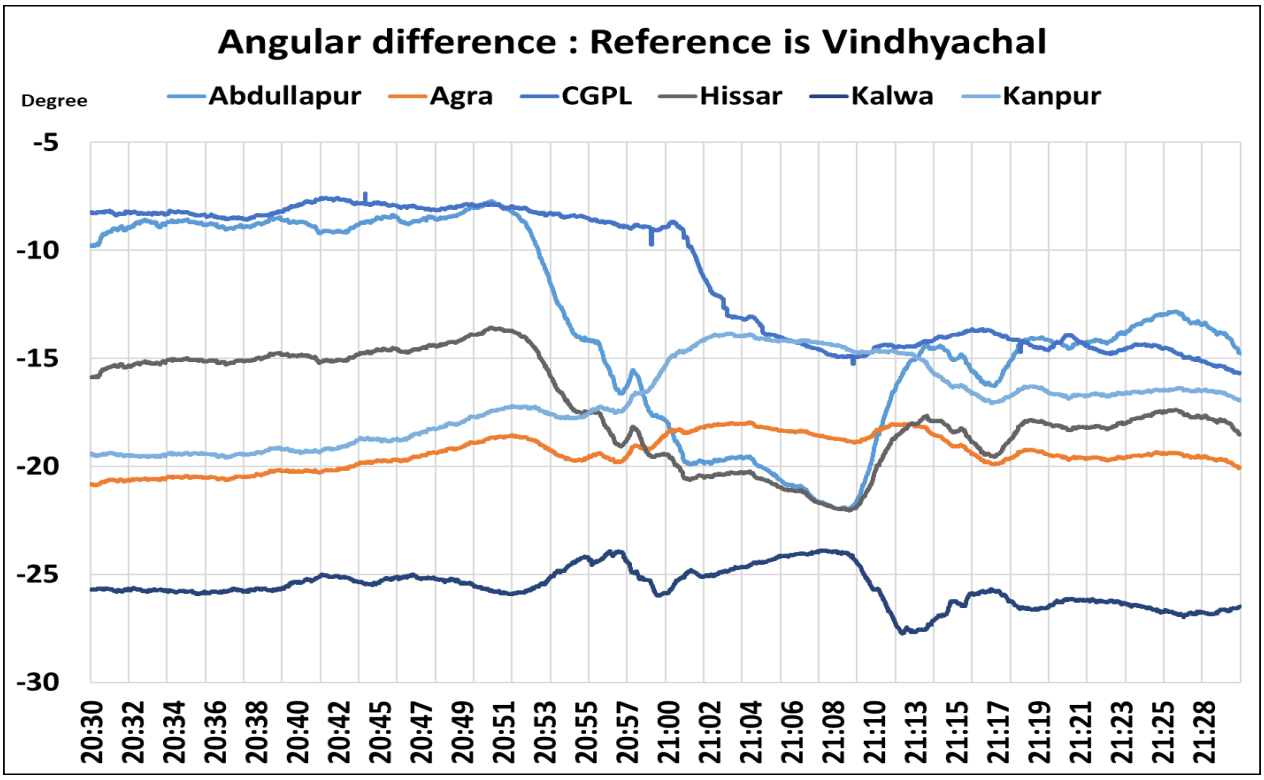
Annexure 12.1 Variation in Angular Separation

Angular Difference of Important Nodes for 05-April-2020 lighting Switch Off Event				
S.No	**Stations**	**Minimum**	**Maximum**	**Average**
1	Vindhyachal –Abdullapur	7.71	21.99	13.34
2	Vindhyachal –Agra	17.96	20.88	19.38
3	Vindhyachal –Bina	11.74	13.23	12.63
4	Vindhyachal –Balipara	-2.99	11.17	5.00
5	Vindhyachal –CGPL	7.34	15.69	11.08
7	Vindhyachal –Farakka	5.84	16.61	11.72
8	Vindhyachal –Gazuwaka	23.70	32.97	29.24
9	Vindhyachal –Hissar	13.56	22.05	17.31
10	Vindhyachal –Jeypore	12.60	21.45	16.36
11	Vindhyachal –Kalwa	23.88	27.77	25.60
12	Vindhyachal –Kalamassery	48.17	67.08	58.07
13	Vindhyachal –Kanpur	13.84	19.60	17.02
14	Vindhyachal –Kolar	37.13	50.17	45.06
15	Vindhyachal –Mysore	45.44	58.64	52.77
16	Vindhyachal -Mariani	-1.47	15.41	7.37
17	Vindhyachal –Binaguri	5.54	16.79	11.28
18	Vindhyachal –Silchar	-3.98	13.16	5.59
19	Vindhyachal -N. Trichur	46.46	63.94	56.71

Note: All Figures are in degrees.
Source of data is URTDSM. The time frame for angular difference statistics is from 20:30 hrs to 21:30 hrs of 05th April 2020 and sampling rate taken is 1 second.


Angular difference : Reference is Vindhyachal
Degree
Abdullapur
Agra
CGPL
Hissar
Kalwa
Kanpur
-5
-10
-15
-20
-25
-30
20:30
20:32
20:34
20:36
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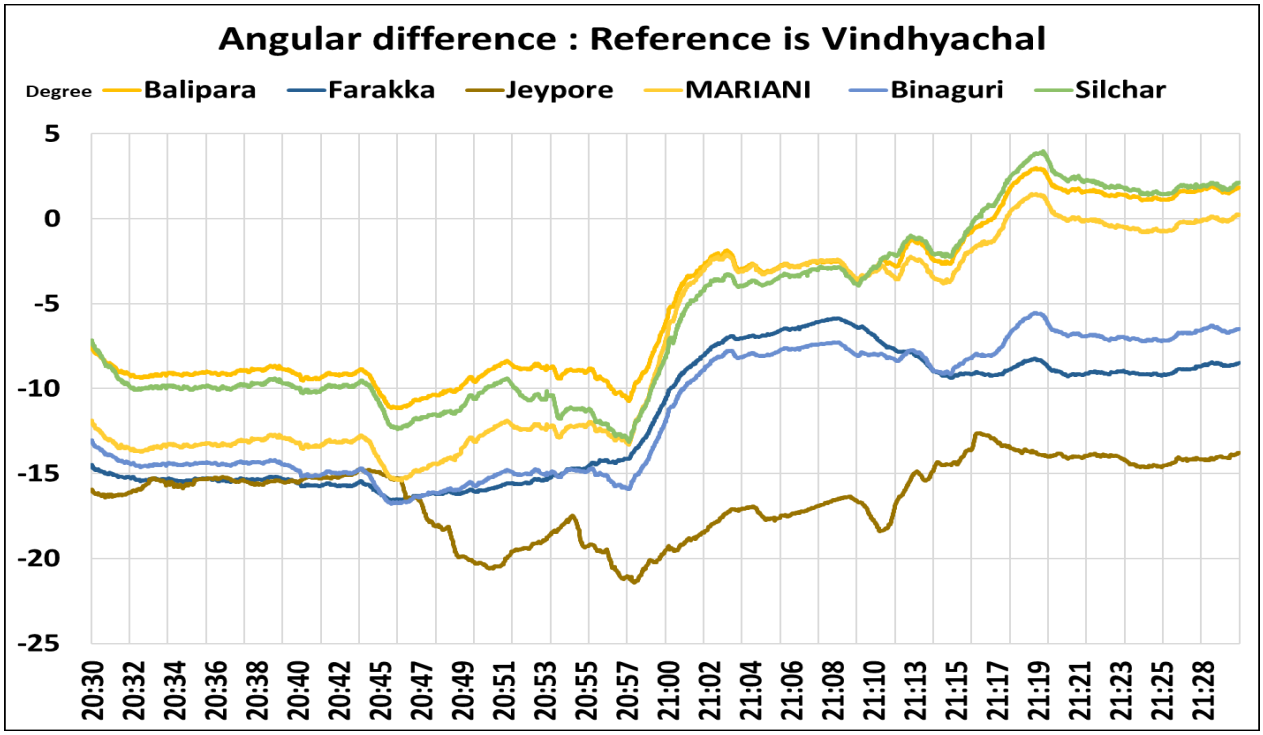
Angular difference : Reference is Vindhyachal
Degree
Balipara
Farakka
Jeypore
MARIANI
Binaguri
Silchar
5
0
-5
-10
-15
-20
-25
20:30
20:32
20:34
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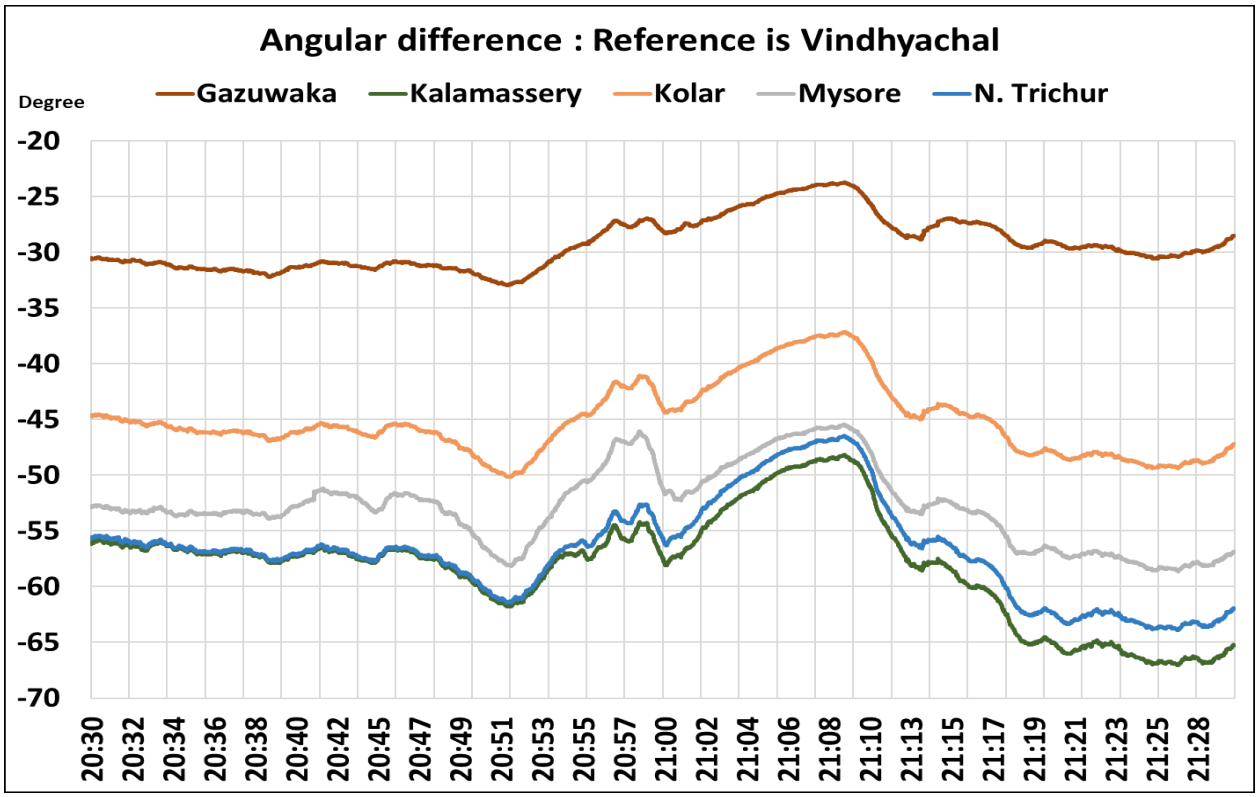
Angular difference : Reference is Vindhyachal
Degree
Gazuwaka
Kalamassery
Kolar
Mysore
N. Trichur
-20
-25
-30
-35
-40
-45
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-60
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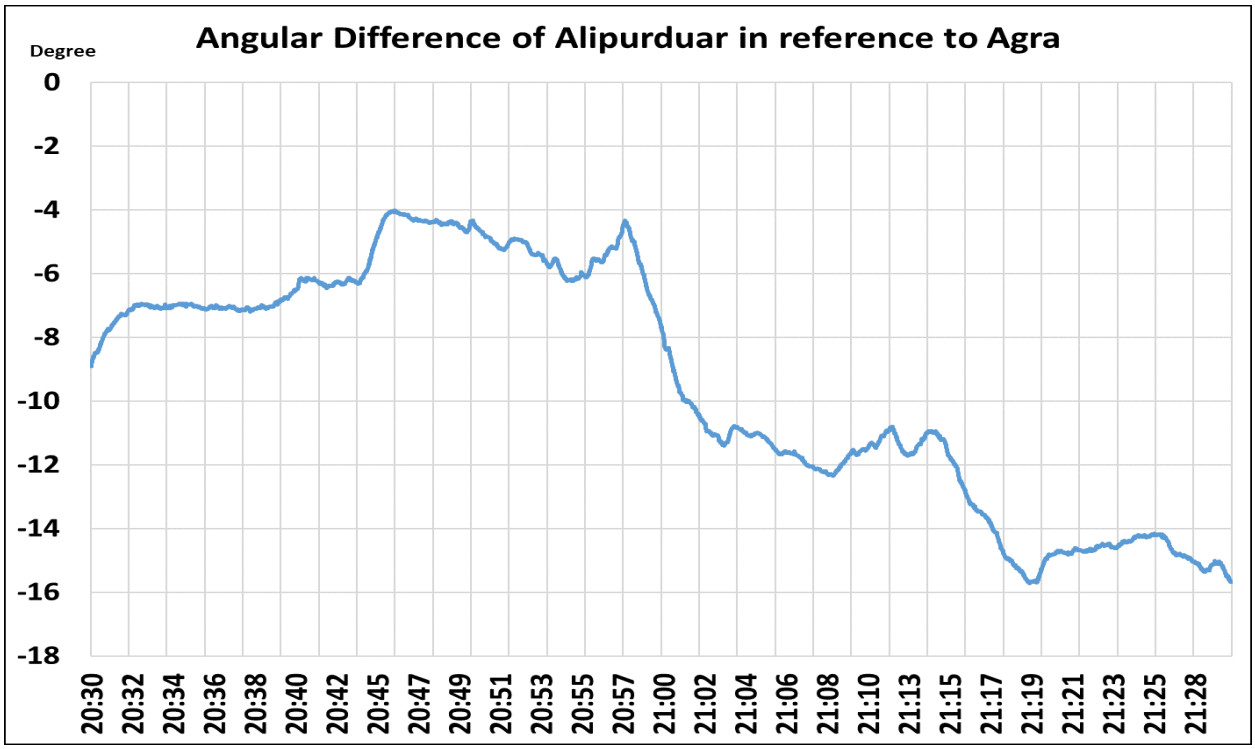
Angular Difference of HVDC Nodes for 05-April-2020 lighting Switch Off Event

S.No	Stations	Minimum	Maximum	Average
1	Alipurduar in reference to Agra	4.01	15.72	9.4
2	BNC in reference to Agra	8.31	22.10	14.17
3	Bhadrawati South bus in reference to its West bus	7.60	11.74	9.96
4	Gazuwaka South bus in reference to its East bus	6.08	16.72	12.87
5	Phadge in reference to Chandrapur	8.04	11.90	9.68
6	Kurukshetra in reference to Champa	-3.64	13.99	3.74
7	Sasaram North Bus in reference to its East Bus	3.43	7.82	5.62
8	Kolar in reference to Talcher	28.80	40.92	34.45
9	Mahendergarh in reference to Mundra	2.44	11.43	6.23
10	Dadri in reference to Rihand	4.56	11.38	7.72

Note: All Figures are in degrees.
Source of data is URTDSM. The time frame for angular difference statistics is from 20:30 hrs to 21:30 hrs of 05th April 2020 and sampling rate taken is 1 second.


Angular Difference of Alipurduar in reference to Agra
Degree
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
20:30
20:32
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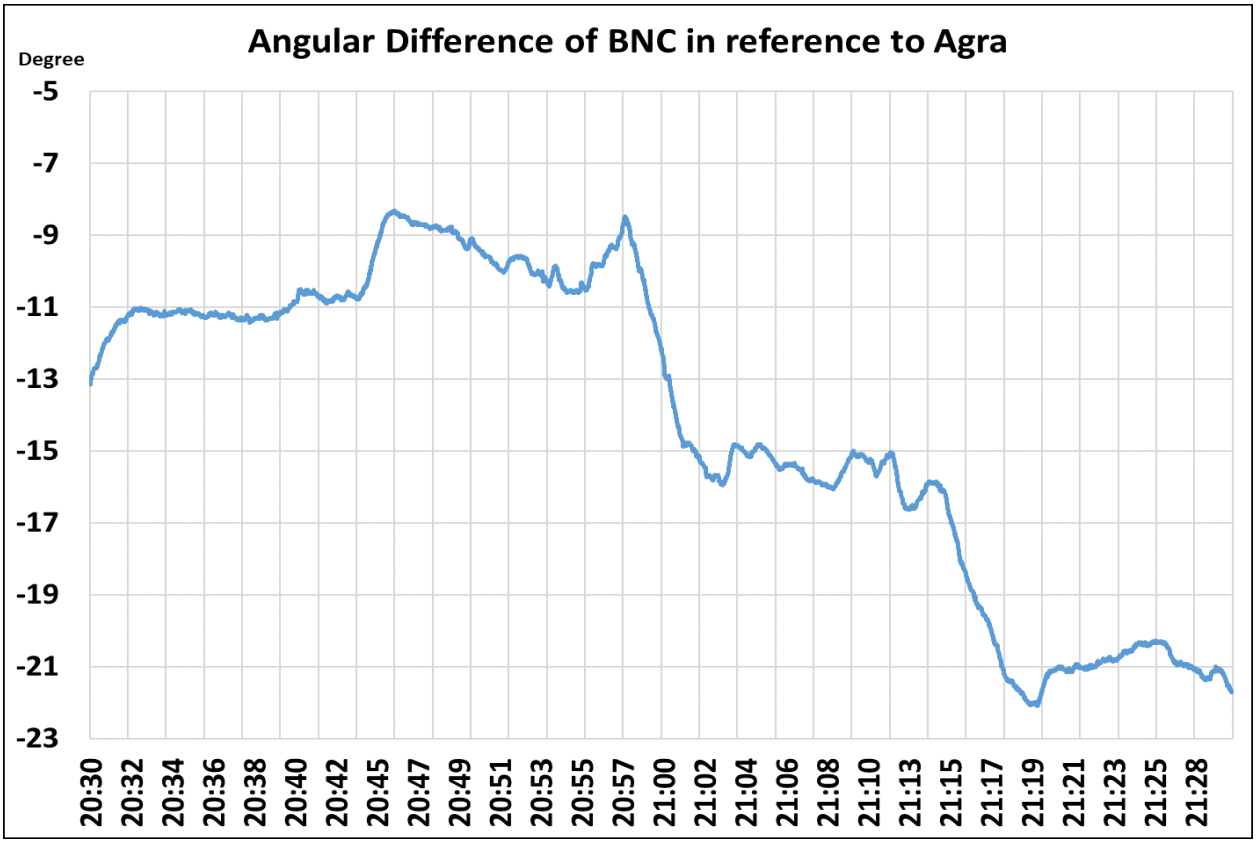
Angular Difference of BNC in reference to Agra
Degree
-5
-7
-9
-11
-13
-15
-17
-19
-21
-23
20:30
20:32
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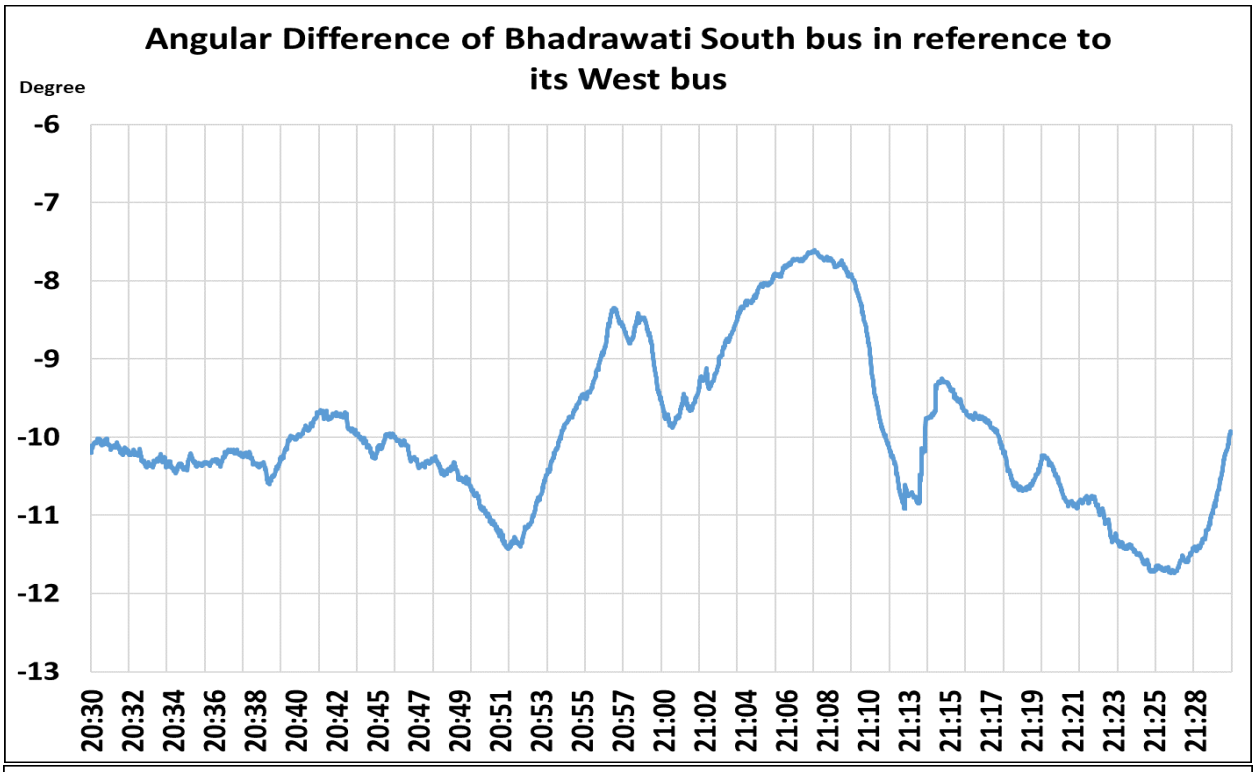
Angular Difference of Bhadrawati South bus in reference to its West bus
Degree
-6
-7
-8
-9
-10
-11
-12
-13
20:30
20:32
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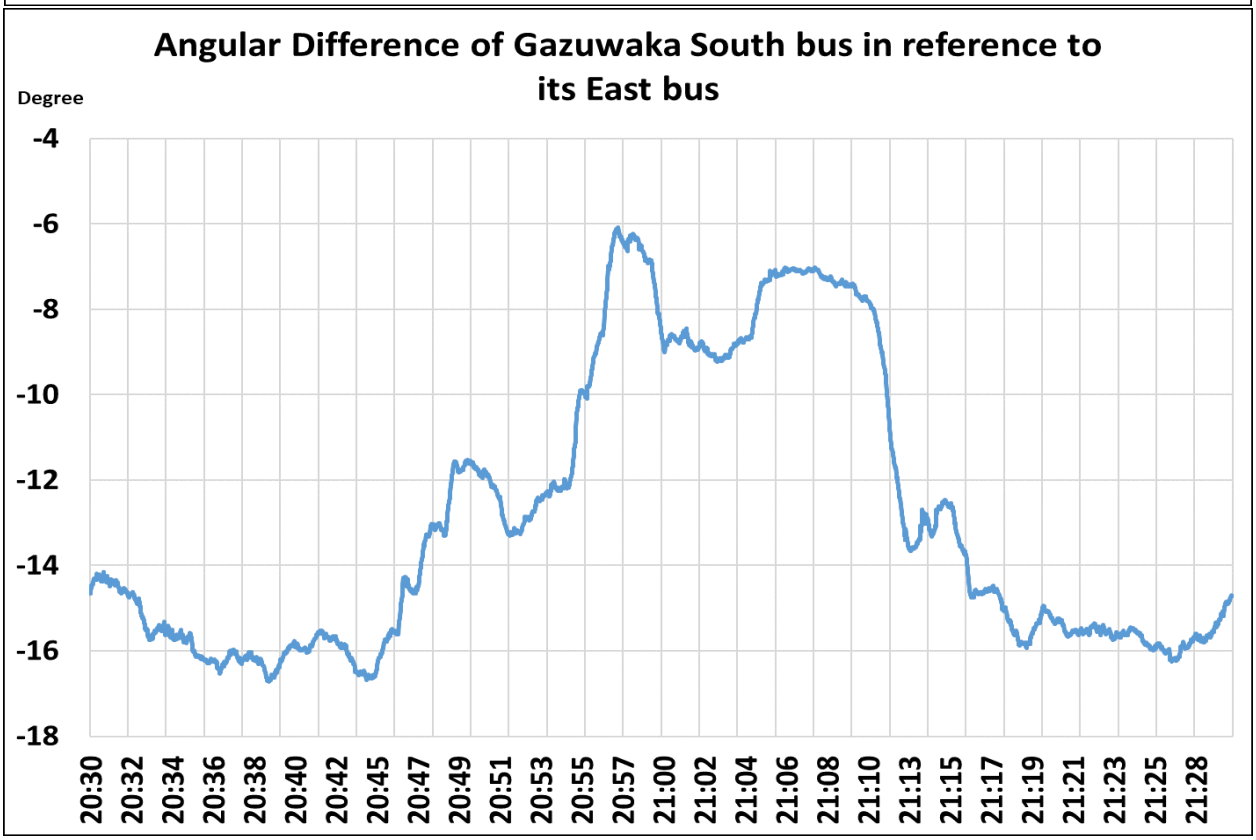
Angular Difference of Gazuwaka South bus in reference to its East bus
Degree
-4
-6
-8
-10
-12
-14
-16
-18
20:30
20:32
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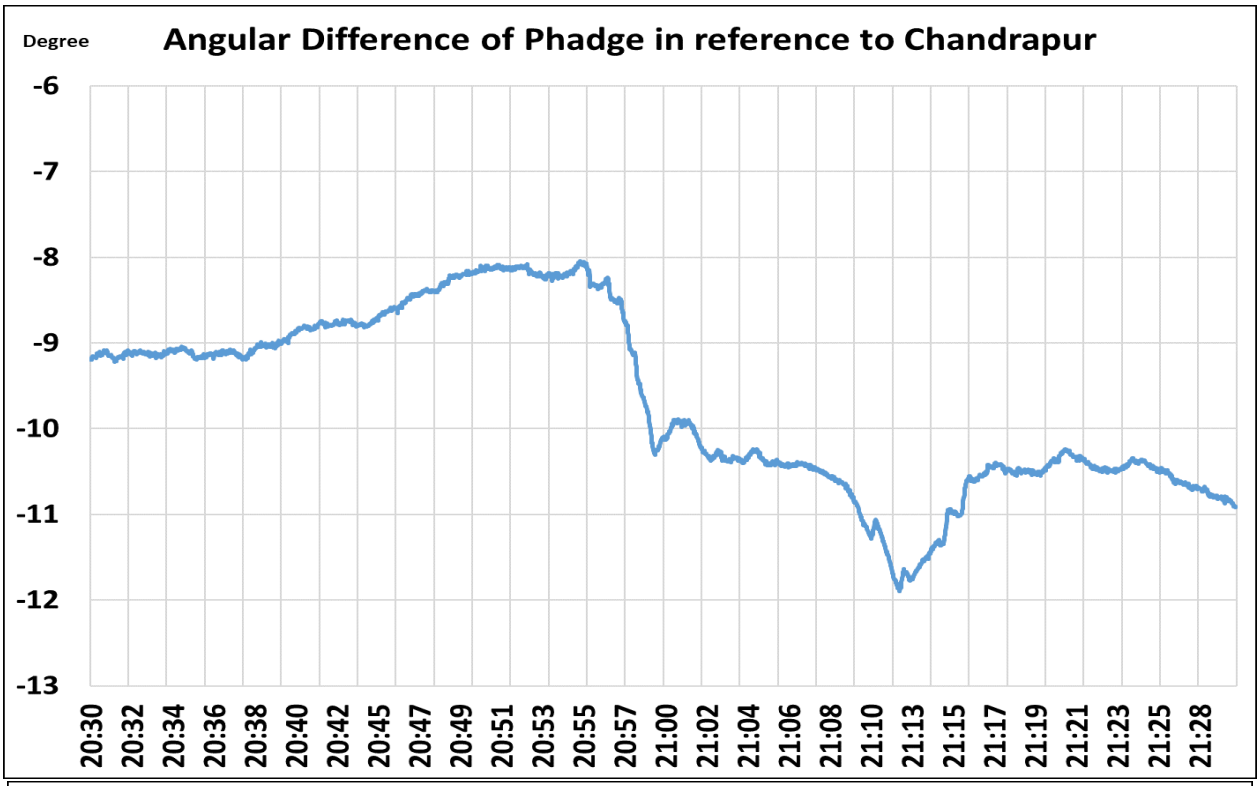
Degree
Angular Difference of Phadge in reference to Chandrapur
-6
-7
-8
-9
-10
-11
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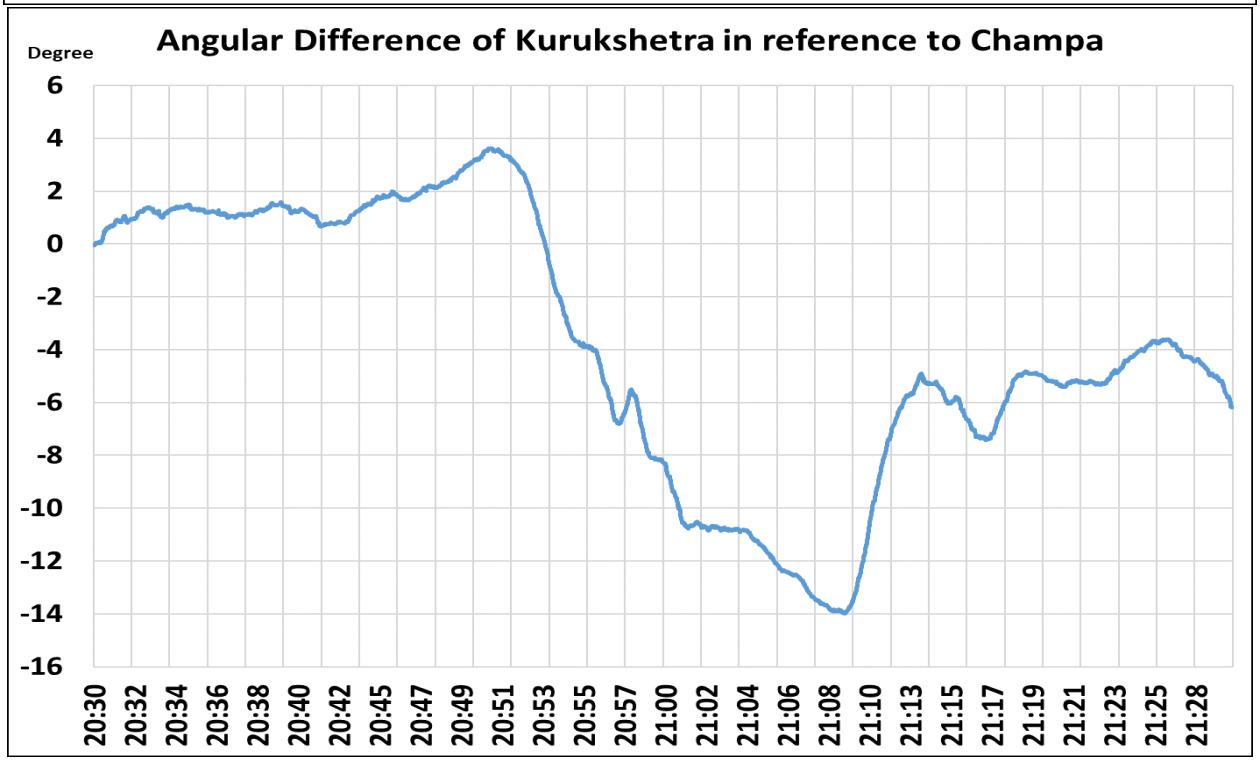
Degree
Angular Difference of Kurukshetra in reference to Champa
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
20:30
20:32
20:34
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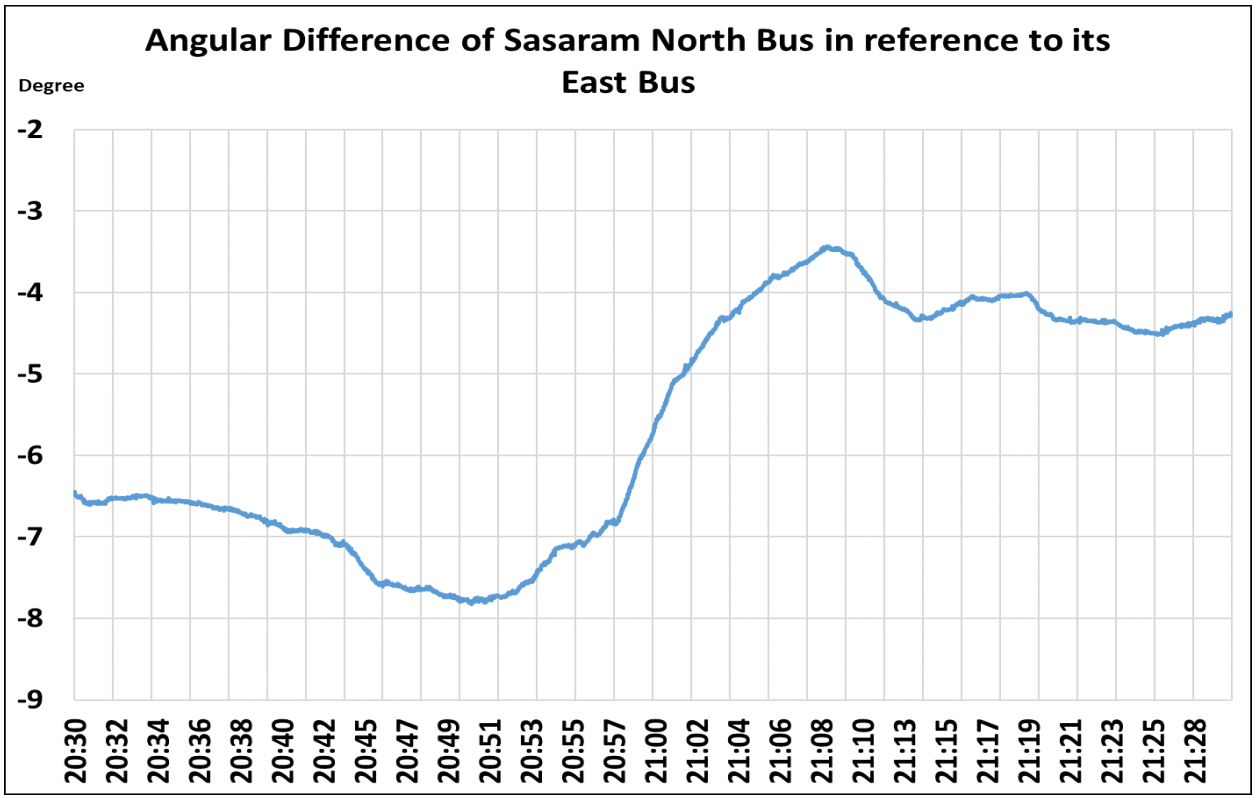
Angular Difference of Sasaram North Bus in reference to its East Bus
Degree
-2
-3
-4
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-9
20:30
20:32
20:34
20:36
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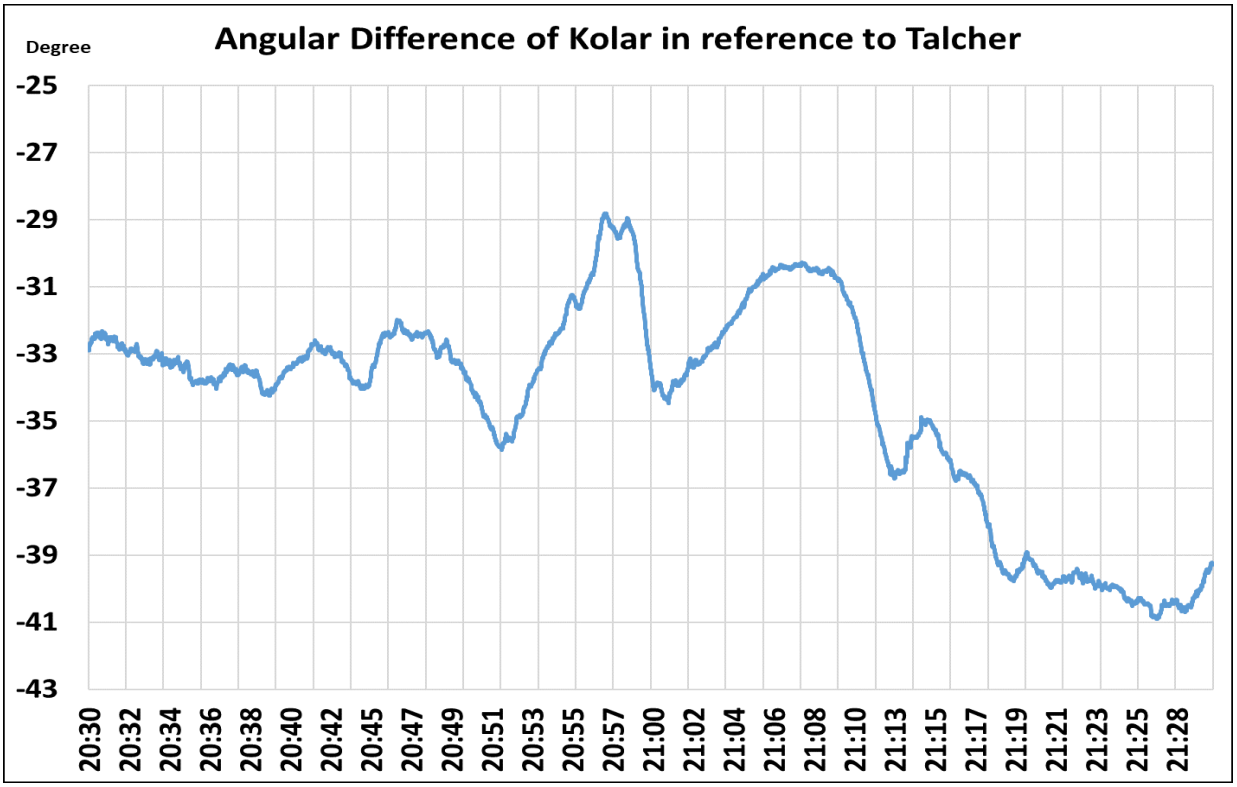
Angular Difference of Kolar in reference to Talcher
Degree
-25
-27
-29
-31
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-35
-37
-39
-41
-43
20:30
20:32
20:34
20:36
20:38
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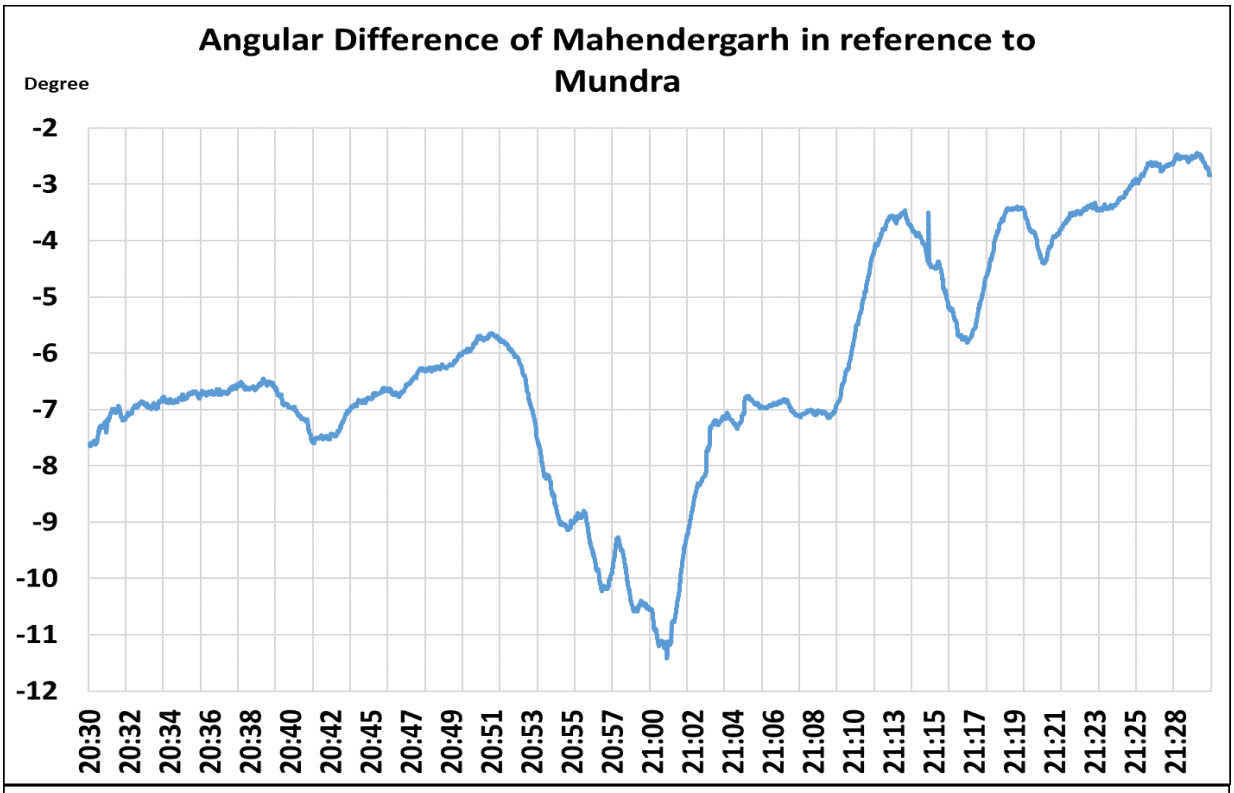
Angular Difference of Mahendergarh in reference to Mundra
Degree
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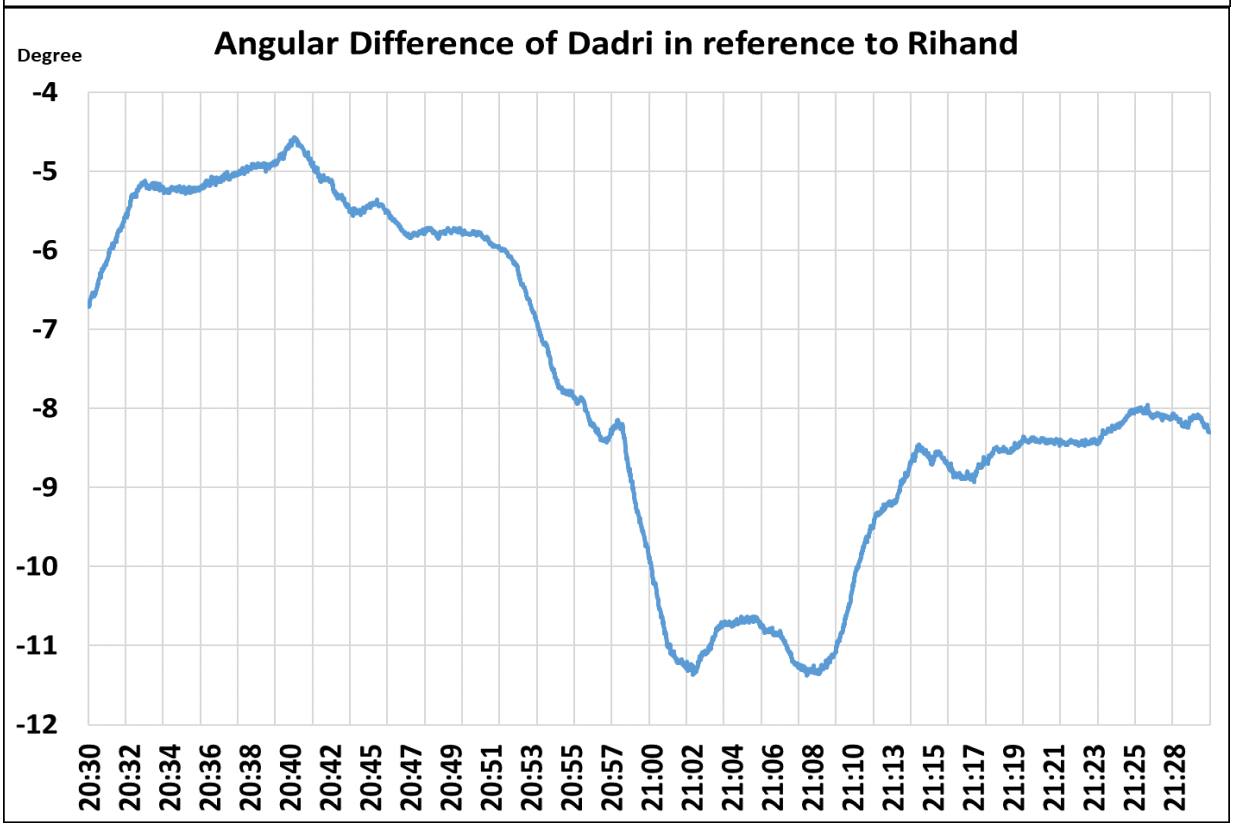
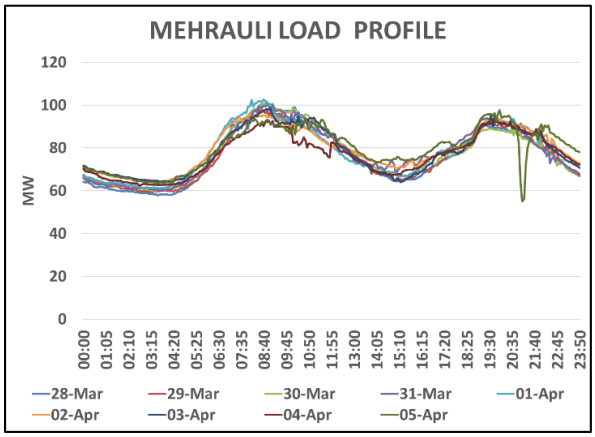
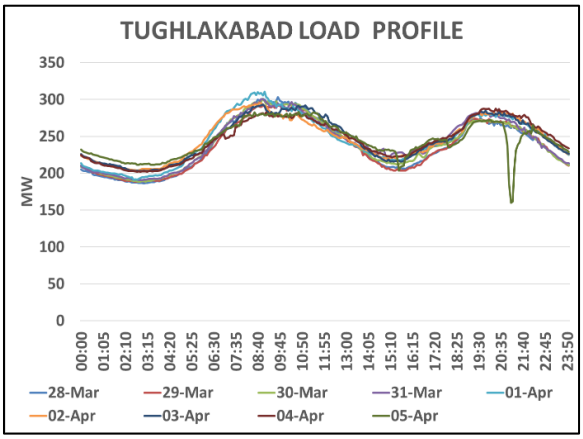
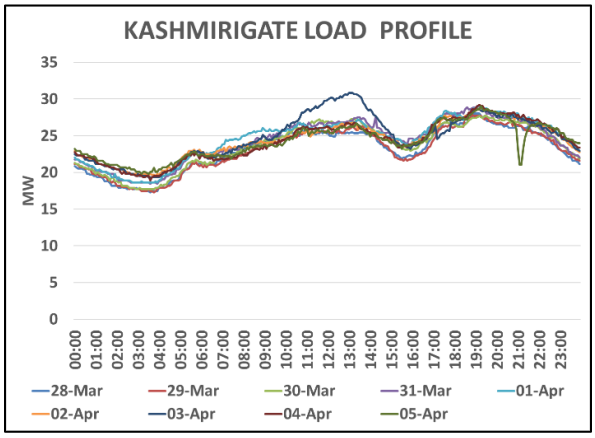

Angular Difference of Dadri in reference to Rihand
Degree
-4
-5
-6
-7
-8
-9
-10
-11
-12
20:30
20:32
20:34
20:36
20:38
20:40
20:42
20:45
20:47
20:49
20:51
20:53
20:55
20:57
21:00
21:02
21:04
21:06
21:08
21:10
21:13
21:15
21:17
21:19
21:21
21:23
21:25
21:28

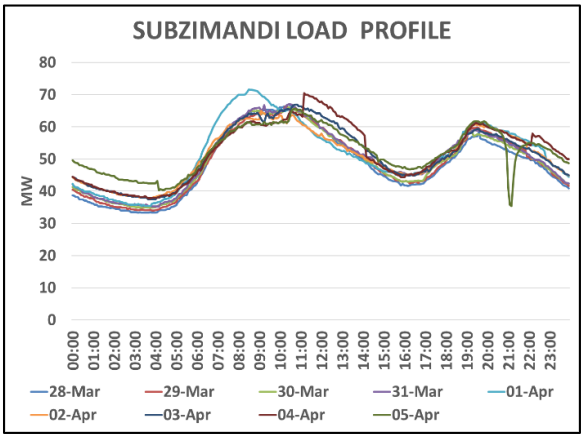
Annexure 14.1 Analysis of Demand Reduction in Delhi System

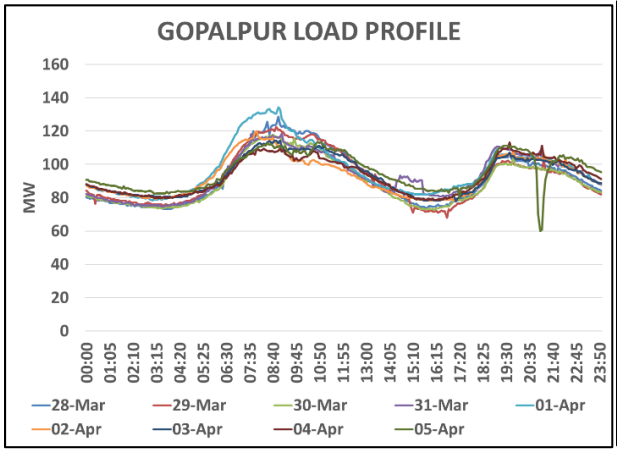
Sample survey of Load Profile within Delhi[12]

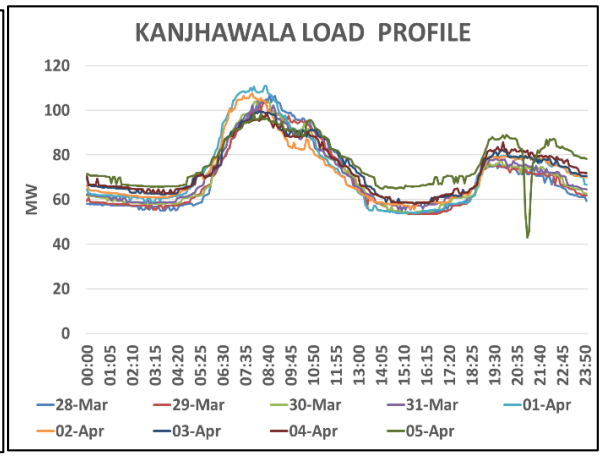






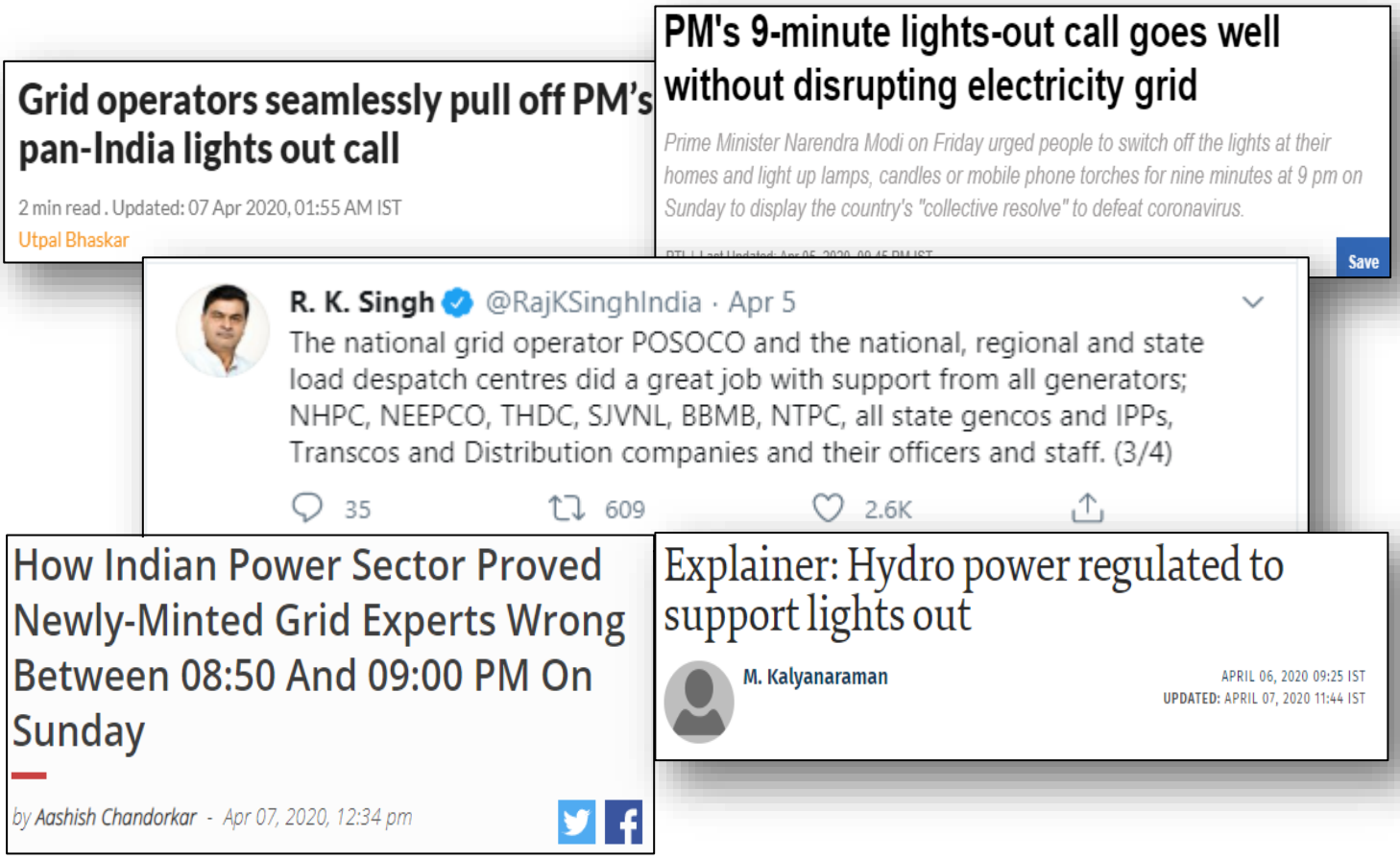






[12] *Source: https://www.delhisldc.org/gridloadcurve.aspx*
Data Sampling Rate: 5 minutes

“There is no darkness so dense, so menacing, or so difficult that it cannot be overcome by light” - Vern P. Stanfill



पावर सिस्टम ऑपरेशन कॉर्पोरेशन लिमिटेड

(भारत सरकार का उद्यम)

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(A Govt. of India Enterprise)

CIN: U40105DL2009GOI188682

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